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ABSTRACT

Primarily intended for those who know the basics of guided design, this book provides a pattern to follow in developing a guided design course. An introductory section provides a background for patterns as characteristic features of and problems to be solved in guided design and surveys three major instructional systems--Audio-Tutorial, the Personalized System of Instruction, and Guided Design--and describes several of their commonalities as instructional systems. The first of two major sections of the book focuses on the development of materials for a guided design course, including the organization of course content, development of instructional units, and planning group projects. The second section concentrates on teaching the course, beginning with experiences that introduce students to the guided design process, procedures for the course, and the social aspects of introducing an innovation to students and colleagues. Three significant barriers to change--student resistance, class size, and other faculty--are addressed, and advice is given to minimize all three. Finally, the guide suggests some patterns of operation that are likely not only to overcome the resistance of other faculty, but possibly to get them interested in changes that are being made. Several figures are provided for illustrative purposes, and appended materials include transition materials, peer evaluation forms, a FORTRAN program for class recordkeeping, and sample guidelines for project grading. A 13-item bibliography is also provided. (DJR)

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The Guided Design Guidebook:

Patterns in Implementation

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In any endeavor such as this, it is hard to identify all of those who have helped along the way. As we think back about those who have helped us develop this guidebook, our attention would go first to Charley Wales who encouraged our efforts and supported the concept of the guidebook. As we formalized our plans and sought assistance, we turned to the Exxon Education Foundation. Exxon, through its Research Director, Richard Johnson, provided the monetary resources necessary to develop and produce this guidebook. We sincerely hope that the guidebook is a fair return for their confidence and generosity and that Exxon will continue to support the Guided Design process.

As we began to create the book itself, we relied on Pam Chaney to type the manuscript. Sharon Shrock provided us with a formative evaluation of our model for the patterns that constitute the essence of this guidebook. The responsibility for the final tone and organization of the guidebook is ours, but we know that many positive changes were made following the detailed reviews given to us by Charley Wales, Gene D'amour, and Bob Stager. Finally, we wish to acknowledge John Yack who was able to save us from ourselves in our, shall we say, modest understanding of book design and the printing process.

Foreword

Although change has become the common denominator of our life, many people still instinctively resist new ideas. One of the best ways to overcome that resistance and encourage change is to provide assistance and that is the purpose of this excellent book. It is a clear, concise, practical guide to some of the important "patterns" that must be considered in the process of educational change.

Those who invest some time reading this book will discover that it is well written, but perhaps misnamed. The primary example used in the book is Guided Design, but the ideas for change will serve anyone who is already using or considering the adoption of any new teaching-learning strategy. Because Guided Design is the example used in the book, these ideas should be particularly useful to those who are interested in a change that emphasizes thinking skills.

Change begins with a clear definition of what must be taught. The authors recommend a hierarchical analysis, a flow chart, and provide examples from management, study and reading skills, and public speaking. That analysis sets the stage for an explanation of how both instructional materials and an appropriate plan for testing can be developed. The analysis also helps the teacher locate points in the course where group work, whether it is Guided Design or something else, might best be introduced.

Three significant barriers to change, student resistance, class size, and other faculty are addressed in the book. Those who follow the advice that is given should minimize all three. The book recommends carefully drawn examples, introductory exercises, and a well thought out plan for organizing small groups to reduce student anxiety. Class size should not be a major barrier; the basis for the book was a class of 180 students. Advice on how to schedule, arrange, and manage both a class that large and the small groups that are formed is provided.

Finally, the Guidebook suggests some patterns of operation that are likely to not only overcome the resistance of other faculty, but possibly get them interested in what you are doing. For many of us who believe change is overdue, that may be the most important part of the book. Change will come, eventually, even to education. Those who read this book will be better prepared for it.

Charles E. Wales

Preface

"The elements of this language are entities called patterns. Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem . . ."

Alexander, et. al., A Pattern Language

We began our joint venture into Guided Design in 1978. Greg had been using Guided Design before this time, but only in conjunction with a standard text and in classes of about 30 students. Bill was an Instructional Development consultant with no experience with Guided Design. We met when Greg found himself facing a large lecture class and wanted to find some way of adapting the procedures of Guided Design to this new situation. We couldn't find anyone else who had dealt with this problem and so we plunged somewhat anxiously into the situation. We used no single Instructional Development model to guide us through the project, but we did rely on a general sense of the systems approach to creating and managing an instructional system. After several years, and a number of experiments, we finally managed to develop an instructional system that could deal with the demands of large lectures and Guided Design. Beyond that, we discovered a number of practical problems for anyone attempting to design and implement an entire course using Guided Design. This guidebook is an attempt to identify and solve these problems.

This book is primarily for people who know the basics of Guided Design. There are aspects that will be of use in other instructional settings, but the book is primarily about patterns in Guided Design. Patterns as characteristic features. Patterns as problems to be solved. And the Guidebook, as a pattern itself, a form to follow in developing a Guided Design course.

We have identified 26 patterns that encompass planning, implementation, and survival of a Guided Design course. The guidebook itself, as a pattern, can be followed sequentially to develop an entire course. However, as most guidebooks work, you can choose to concentrate on only one area and select the patterns most relevant to your own situation.

The guidebook is divided into three major sections: A Background for the Patterns, Planning for Guided Design, and Implementing Guided Design. In the Prologue we have surveyed three major instructional systems—Audio-Tutorial, the Personalized System of Instruction, and Guided Design—and described several of their commonalities as instructional systems. In Part I we focus on the development of materials for a Guided Design course. We look at how to organize course content, develop instructional units, and how to plan the group projects. In Part II we concentrate on teaching the course. We begin with experiences that introduce the students to the Guided Design process, move on to procedures for managing the course, and finally, discuss the social aspects of introducing an innovation to students and colleagues. Finally, there is also an Appendix of materials that should help you implement some of the patterns.

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Dedication

For our parents
Monica and Cyril,
Martha and Tom.
All things considered this has to be the most expensive book on their shelves.

PROLOGUE

A BACKGROUND FOR THE PATTERNS

"What any person in the world can learn, almost all persons can learn if provided with appropriate prior and current conditions of learning."

Benjamin Bloom, 1978

Bloom's conclusion is not the result of idle speculation. It comes from a careful analysis of the theory and practice of educational programs. In fact, Bloom found the evidence so powerful that he went on to assert that about 95% of the school population could learn most anything under the appropriate conditions. As teachers we agree with Bloom, but we also recognize the problems of creating "appropriate prior and current conditions." The creation of these conditions is not impossible—but it does take time, resources, and a systematic effort. We hope you will find this guidebook a useful resource in this effort.

While the guidebook is primarily about Guided Design, it is also about systematic approaches to instruction. In this Prologue we want to discuss four areas that provide a background to the patterns of Parts I and II of the guidebook:

- We will look at how Bloom has mapped the shifts in prevailing American instructional philosophy. This evolution has brought us to a point where systematic approaches to the design of instruction have produced significant and demonstrable gains in mastery learning.
- We will examine Patricia Cross' analysis of five characteristics of educational systems that foster mastery in instruction.
- From this analysis we will describe briefly three approaches to instruction that have embodied Cross' characteristics: Postlethwait's Audio-Tutorial (A-T), Keller's Personalized System of Instruction (PSI), and Wales' Guided Design.

- Finally, we will look at A-T, PSI, and Guided Design systems and show how they share common patterns. In so doing, we want to illustrate that regardless of the instructional system you may be using, many of the patterns we describe in the guidebook will be useful to you. From these examples, we hope to show how you might use these patterns in your own approach to an instructional system.

Philosophies of Instruction

In Human Characteristics and School Learning, Bloom raised serious questions about schooling in our society. He argues that the main import of his work "is that human nature is not the barrier to educational and cultural development that philosophers, politicians, social scientists, and educators have frequently alleged." For Bloom, what is important in educational and cultural development is the quality of the conditions that surround school learning. Bloom documents the evolution of educational research and practice that has led to his assertion that mastery in learning is a realistic goal.

GOOD AND POOR LEARNERS

Bloom sensed that the first dominant philosophy of instruction was that "there are good learners and there are poor learners." This view of education is typified by the normal curve—learning ability was distributed in a statistically normal manner, and that learning abilities would remain stable throughout one's life. It was believed that good learners could learn complex material and that poor learners would learn only the simplest and most concrete skills. The consequences of this assumption are clear—there is little that the schools can do about learning ability. Whether these differences are due to genetics or environment, the role of the schools is to constantly weed out poor students while encouraging and channeling the better ones.

FAST AND SLOW LEARNERS

The next philosophy to emerge was that "there are faster and there are slower learners." Spurred on by John Carroll's work in the early sixties, educators argued that learners differed in their rate of learning. This philosophy held that most learners could achieve mastery of a subject provided the learner was given sufficient time and help when needed. In this situation, Carroll suggested that if all students were given the same amount of time to learn a subject, then mastery would be normally distributed. However, if instruction and time constraints were adapted to student needs, then achievement would no longer be normally distributed, but rather, skewed toward the upper end of the distribution.

MASTERY LEARNING

Today, Bloom would argue that "most students become very similar with regard to learning ability, rate of learning, and motivation for further learning when provided with favorable learning conditions." This position is the result of continued research in the field that asserts that "learning characteristics such as good-poor and fast-slow are alterable by appropriate school conditions; that under appropriate conditions almost all can learn whatever the schools have to teach. It indicates that special and very favorable conditions may be needed at some stages of learning, but that over time these conditions may gradually be discarded." What then, are some of these conditions for learning?

Fostering Mastery

In *Accent on Learning* (1976) Patricia Cross argues that "the individualization of learning lies at the heart of the instructional revolution." Individualization in learning systems can be implemented using a number of strategies, e.g., PSI, A-T, CAI. Regardless of the strategy used, effective instructional systems have certain characteristics that foster mastery in learning. Cross' five characteristics are: specificity in goals, modularization of lesson units, activity in learning, self-pacing of instruction, and feedback on performance.

SPECIFICITY IN GOALS

The old axiom "if you don't know where you are going, how will you know when you have arrived?" applies to instructional systems. We often say we want the student "to understand," but this often induces ambiguity in our instruction. How do we know when someone "understands?" Goals need not be formulated using a stilted and inflexible format, but there does appear to be strong evidence that if a learner knows explicitly what is expected then learning will increase.

MODULARIZATION OF LESSON UNITS

With a precise statement of the course goals, one can then begin to organize the instruction. One of the more important characteristics of successful instructional systems is that they tend to organize the content into lesson units that emphasize one concept at a time. These units can be developed and delivered via single lectures, self-instruction packages, computer based instruction, or any number of other vehicles. What is important for their success is the tactic of presenting single concepts or a group of tightly related concepts at the same time; concepts directly linked to the goals statement for the particular unit being covered.

ACTIVITY IN LEARNING

Given a clear statement of goals and their associated modularization, the focus is now on the learning activities themselves. Effective instructional systems emphasize active rather than passive involvement in learning. As contrasted with the stereotypical lecture session, individualized mastery approaches will expect the learner to assume active involvement in the class. The teacher is no longer responsible for pouring knowledge into waiting vessels. Rather the "teacher assumes the role of manager; he or she prepares materials, diagnoses, prescribes, motivates, and serves as a resource for the student. The emphasis is on learning rather than teaching." Students are given opportunities that challenge them to behave as professionals in the discipline would when faced with a problem . . . and in so acting as a professional, they also learn as one.

SELF-PACING OF INSTRUCTION

We all recognize that individuals differ. People wear different clothes, drive different cars, have different ideas. Despite this daily recognition of individual differences, much of teaching is based on a lockstep presentation of content. Thus students who have mastered material can be found sitting bored while those who don't understand what is being taught may be panic-stricken.

Exemplary instructional systems recognize this difference and allow learners to progress at their own pace. To be sure, there are often practical limits to how much time a student can spend with a given unit of material; but strategies as simple as recording a lecture can often allow a learner to master material that would normally have been lost in a lockstep process. Of course, there are more sophisticated approaches to self-pacing, but the concept is still the same—"not only do individuals differ from one another, but most of us differ from time to time and from task to task in our own learning efficiency." And by allowing each learner to control the pace of instruction, we can increase learning.

FEEDBACK ON PERFORMANCE

"Any questions?" That common interrogatory peppers most of our educational lives. The equally common silence also follows that question. From our past experiences we often know which concepts are particularly difficult and need further clarification. We also know that when we ask if there are any questions, we are more likely to receive blank stares than questions on the content. When the students fail the item, *en masse,* on the exam we can expect to hear that "it made sense at the time." Lots of practice and feedback on that practice is the antidote to this problem. Students often don't know if they know until they have had a chance to apply their knowledge. Practice and feedback systems are a critical part of any effective teaching strategy. They can be as simple as specific content questions asked during the course of a class or as intricate as detailed branching computer programs in a CAI course.

These principles are not ethereal constructs that are impossible to implement in the classroom. Nor does one need thousands of dollars in order to create a system that incorporates these principles. There are, in fact, three such established instructor based (as opposed to computer based) instructional strategies that have been implemented in the classroom. In the next section we will describe these approaches: Audio-Tutorial, the Personalized System of Instruction, and Guided Design.

Instructional Strategies That Work

The three instructional strategies that we want to discuss come from different roots but share many commonalities. Postlethwait's training is that of a botanist, Keller, a psychologist, and Wales, a chemical engineer. The A-T approach is the oldest (begun in 1961) followed by PSI (1968) and Guided Design (1969). These are not instructional panaceas for they do have their weaknesses, but their strengths far outweigh their liabilities.

THE AUDIO-TUTORIAL APPROACH

Postlethwait (1972) began with the assumption "that the best learning situation is the 'teacher on one end of the log and the student on the other.' " The purpose of the A-T system is to simulate this setting. Thus Postlethwait emphasizes "tutorial" in describing his system. An A-T course is characterized by the following aspects:

- *Minicourses.* Course content is typically organized into units called minicourses. Each minicourse has a specific set of goals and test procedures.
- *Independent Study Sessions (ISS).* Audio-tutorial programs are placed in a learning center where students can come at their convenience. At the center they first pick up announcements, unit objectives, reading assignments, and any other materials needed for study. They then proceed to an A-T carrel where they are guided through the lesson via an audiotape. This simulation of the one-to-one tutorial allows the student to proceed at his or her own pace, stopping as desired to use additional references, equipment or seek peer or instructor help. Students can skip material already known or review difficult material as often as desired.
- *General Assembly Session (GAS).* This session is scheduled on a weekly basis and is the only large group meeting in the course. GAS activities include an occasional lecture, special films or demonstrations, major exams, or any other activity that can be done most efficiently and effectively with a large group. Attendance is only required for certain special events. All presentations are limited to 30 minutes, with the final half of the class period used by the student to make a written summary of the presentation.
- *Small Assembly Session (SAS).* This session involves eight to ten students and an instructor. It is held weekly for approximately 30 minutes. The primary purpose of the session is to exploit the principle that "one really learns a subject when one is required to teach it." Each student is expected to practice giving a short lecture about each of the concepts covered in the ISS. The instructor leads the group by presenting topics (objectives) in the sequence programmed for in the ISS. Students are selected on a random basis to give a mini-lecture or otherwise demonstrate the skills of an objective to the rest of the group. After a presentation is completed other

students may elaborate or correct what was presented. Additional points can be earned through these comments. Students can never be certain which objective they will need to address, thus encouraging them to master all. On occasion, the instructor may also wish to use a written quiz to assess mastery.

- *Grading.* Grades are usually assigned as a function of demonstrating mastery for a specified number of mini-courses. By mastering the minimal level of skills the student earns a "C." Additional activities are available for which points are awarded, with a certain number of points needed to earn "B" or "A."

PERSONALIZED SYSTEM OF INSTRUCTION

Keller (1968) presented an instructional method rooted in learning theory. His strategy was based on the mastery of individual units through self-pacing and feedback systems. Keller summarized his teaching system as encompassing the following features:

- *Unit perfection.* Students are expected to master each unit before proceeding to the next unit. To aid learning, the instructor must take several steps: 1) Content must be broken into manageable units appropriate to the student's entry level skills, 2) Each unit must build on the next, 3) Each unit contains a study guide with behavioral objectives for that unit, 4) Instructional material is taken from, or adapted from, books, slides, articles, tapes, etc.; though typically the material is print based in contrast to the A-T approach.
- *Self-pacing.* Students read the unit materials and interact with others as they feel necessary to master the unit objectives. The amount of time spent on a given unit is, ultimately, an individual decision.
- *Lectures.* Lectures and demonstrations are intended to serve as motivational tools. Lectures in PSI systems have come under examination from a number of perspectives. PSI lectures are held less frequently than A-T lectures and many studies have shown that students view these lectures as minor aids in the learning process—though there seems to be an affective need to maintain student-professor contact and interaction that the large group lecture still serves.

- *Repeated testing.* There are multiple tests for each unit. A student is not penalized for failing a test for a given unit. Tests are scored immediately, and the students are provided with feedback on their performance. A student is given a number of opportunities to demonstrate mastery of the content and may continue study and testing until mastery for a unit is demonstrated.
- *Proctors.* Tests are administered by proctors who are usually other students from the course who have mastered the material or who have already taken the course. The proctors give the test takers feedback on their performance and advise them regarding additional work when necessary. The proctors are such an important component of the PSI process, that Keller feels it is these student peers who make the system a "personalized" one.
- *Grading.* Typically a student can earn a grade of "C" by demonstrating mastery of each of the course units. Grades of "A" and "B" are often determined by extra work or exams that assign point values, respectively, for work completed or exam scores.

For both A-T and PSI, there have been criticisms that they emphasize mastery of the subject matter over more analytical skills. We feel that neither system in and of itself prohibits the development of more intellectual skills; however, the history of these movements has been such that content mastery has been an emphasized goal. An approach that addresses both content mastery and higher order thinking skills, specifically problem solving, has been developed and deserves further examination.

GUIDED DESIGN

Wales (1977) developed the Guided Design approach with the objective of helping students to become "adaptive, creative, independent people." He reasoned that before students could reach that goal, they would have to obtain three different types of skills: knowledge, decision-making, and values. Traditional teaching, and even the other methods discussed here, typically concentrate on only the first, knowledge. In order for students to learn decision-making skills and value skills a completely new educational system must be designed.

Knowledge skills can be learned through the course content material, which can be transmitted through a number of ways, including lectures, audio-tutorials, etc. However, decision-making skills can be learned only by following the steps of a "guide" or mentor as that person makes decisions to solve unstructured, open-ended problems. The student must practice applying these decision-making steps to progressively more difficult problems. The mentor must be available at each step of the process to point out errors or answer questions. It is also most helpful to the student if feedback can be given at each step to show how an experienced decision-maker might have performed that step.

Likewise, value skills, or the ability to utilize one's value system and to appreciate the value systems of others, is something that is best learned through practice. Since one is best introduced to other people's value systems by interacting with others, this skill is best obtained by working with others on problems that require the explicit consideration of each person's value system.

To achieve the ends described above, the Guided Design methodology uses the following approach:

- *Independent Study.* Rather than spending class time teaching knowledge, students learn the course content material outside of class from programmed instruction materials, audio-tutorial lectures, or a textbook supplemented by teaching notes. Students are given specific content-performance objectives for each set of material.
- *Small Groups.* Most real-world decision-making is done in a group setting. Therefore, students are organized into groups of 4-6 to apply their knowledge skills in solving unstructured, open-ended problems. These problems require students to follow a prescribed sequence of decision-making steps, using their value systems in the process. In general, all class time is spent working in these groups on decison-making projects.
- *Guided Design Projects.* Each project is designed so that students must apply the course content material that they have just learned, thus creating a need for their knowledge skills. The projects proceed in an instruction—feedback format with each instruction usually corresponding to a step of the Guided Design decision-making process. After a

group has acted on an instruction its members are given feedback indicating how an experienced decision-maker might have performed that step. This feedback does not represent a "correct" answer, but provides guidance and indicates some other possible ways the students could have performed the instruction.

Each project requires that the students develop a final detailed solution to the problem, which is usually presented in either an oral or written report, which is graded.

- *Instructor as model and mentor.* Rather than serving only as a transmitter of knowledge, the instructor in a Guided Design course must also act as model and mentor. He or she must help to guide students through the decision-making process and show them how a professional applies both knowledge and values in solving real problems.
- *Competency-based testing.* Because knowledge of content material is required in order to solve the Guided Design projects and to share duties in a group, a competency-based approach to testing is usually taken. Tests are thus developed from the performance objectives established for the independent study material.
- *Grading.* Grades are usually based on both test scores and grades assigned to project reports. Tests may cover either content material or decision-making skills or both. The major portion of the course grade is generally based on project report grades.

Patterns

While we presented only brief descriptions of A-T, PSI, and Guided Design, you probably had no trouble identifying certain themes to each of these instructional systems. In fact, they all possess, at some minimum level, the five characteristics for individualized systems that Cross described: goal specificity, small lesson units, activity in learning, self-pacing in instruction, and feedback on performance. If you are designing an instructional system using any of these strategies, or creating your own variant, you will soon find that you need more information about each of these components. In addition, you will probably find a few problems that haven't been addressed in these systems. This is where the patterns of Parts I and II come in.

Suppose you have decided to develop self-instructional units for Guided Design, or any other system. These units should have certain minimal components to insure successful instruction. These components are the patterns of instruction. You can choose from the patterns we have identified as they meet your needs and follow them as guides in creating instruction. For instance, the patterns we have identified for self-instruction are: *Rationale, Statement of Skills, Content Presentation and Testing.* You may not need each of these patterns for your own system, but should you choose to use one we have provided guidelines for creating that pattern.

If you are using proctors in a PSI course or student aids in Guided Design, you might review *Personnel.* If you are concerned about keeping track of what is going on in your class, especially if you have a large group, you could review *Record Keeping.* One of the most common problems in implementing any innovative instructional system is resistance from the students as well as from your colleagues. Students accustomed to passivity in instruction are often confused about how to cope with activity in learning. The patterns of Chapter 4, Transition, show how to lead your students from passivity to activity in Guided Design. While Chapter 4 is most specific to Guided Design, it is conceptually relevant to any new instructional system. Collegial resistance is also discussed in Chapter 6, and general problems with innovation are addressed in the patterns: *Accepting The Innovation, People And Change,* and *Common Issues.*

The patterns that follow are only a beginning, both for us and for you. As you begin to experiment with our patterns we are sure you will find more of your own. We like these thoughts from *A Pattern Language:*

> It is essential then, once you have learned to use the language, that you pay attention to the possibility of compressing the many patterns which you put together, in the smallest possible space. You may think of this process of compressing patterns, as a way to make the cheapest possible building which has the necessary patterns in it. It is, also, the only way of using a pattern language to make buildings which are poems.

PART I

PLANNING FOR GUIDED DESIGN

Chapter 1: Organizing the Course Content
- Hierarchical Analysis
- Placement of Guided Design Projects

Chapter 2: Developing Instructional Units
- Rationale
- Statement of Skills
- Content Presentation
- Testing

Chapter 3: Group Projects
- Project Content
- Writing the Project

Overview

After reading the Prologue, or through your own experience, you are probably aware that unlike the traditional lecture approach to teaching, Guided Design requires the development of a considerable amount of written material. At the minimum, you will need to develop the self-instruction units and the instruction and feedback components for the Guided Design projects. By far, the greatest effort you put into your Guided Design course will be in developing these written materials.

The purpose of this section is to ensure that your efforts are successful. A considerable body of knowledge has been developed around ways to write effective instructional materials. We have combined that knowledge with our own experiences from working with Guided Design to present some suggestions and guidelines that you can follow to successfully develop your own instructional materials.

One thing we have found that is essential for successful development of course materials is a hierarchical analysis. Thus, this section begins by showing you how hierarchical analysis can be used to develop a course map that will serve as the blueprint for your Guided Design course. You will find that we refer back to this hierarchical analysis throughout the entire book.

The next two chapters present some guidelines and techniques that you can use in writing the self-instruction materials for your course and in developing the Guided Design projects. Once you finish this first section you should be able to develop a hierarchical analysis for your course then use it to go on and write appropriate self-instruction units and group projects. After this, you will be a long way toward a successful Guided Design course.

CHAPTER I

ORGANIZING THE COURSE CONTENT

Introduction
Hierarchical Analysis
  Creating the hierarchy
  Hierarchy examples
Placement of Guided Design Projects

Introduction

Most instructors have thought about the structure of their courses and how all the parts fit, or don't fit together, but few have never really analyzed the whole. Since most of us use a text, we tend to follow the author's organization and only occasionally rearrange sections or chapters. Use of a text can often lead to a sense of dissatisfaction, but with no real notion of how to really reorganize the material.

An alternative approach is to create a course map or hierarchy. Doing so will force you to look at what you want the students to learn and how all the parts of the course fit together. Using a hierarchical analysis the course can be planned to form a unified whole. Students will progress in a logical sequence from one topic to another. The material flows smoothly and builds upon itself. Students can quickly see that one unit is important because the next will build on it. And finally, a complete analysis will enable you to pinpoint the placement of the Guided Design projects so that they tie together the instructional units, reinforcing both the content itself and an understanding of how the separate components are linked together.

HIERARCHICAL ANALYSIS

Learning theorists have found that many learning goals can be thought of as hierarchical in nature, i.e., subordinate skills are prerequisites to the final task. More specifically, some of the assumptions of this approach are:

- A final goal can be analyzed into component skills that are quite distinct from each other.
- The component skills are mediators of the final goal, i.e., mastery of a lower level skill is necessary to achieve the next level of performance; non-mastery significantly reduces the probability that the next level task will be mastered.

Figure 1.1 is an illustration of the relationship of the components that mediate a final goal.

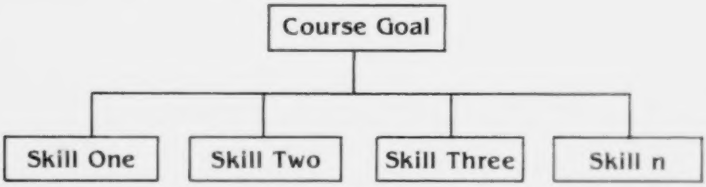


Figure 1.1. Hierarchical relationship of skills to course goal.

Figure 1.2 illustrates a relationship where the three components have been further analyzed and additional components have been identified.

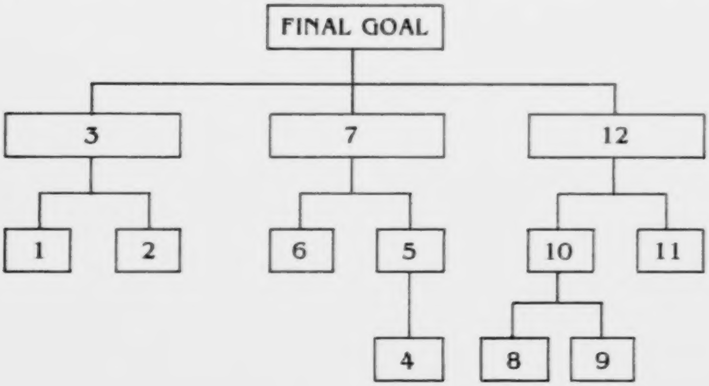


Figure 1.2. Extended hierarchical analysis.

In this example, Skills 1 & 2 would need to be taught before teaching Skill 3. Skills 4, 5, & 6 would likewise need to be taught before Skill 7, skills 8 & 9 before 10, and 10 & 11 before 12.

Depending on how a course was organized one might also need to proceed from left to right, i.e., Skill 3 to be mastered before Skill 6, both of which to be mastered before Skill 2. However, in other situations the left to right ordering would not be critical and one could teach Skills 3, 7, and 12 in any order.

It is important to note that the application of the hierarchical analysis procedures does not guarantee an effective sequencing of units within the course; rather it produces a hypothesized sequence that may succeed. A hierarchical analysis is a "best guess" sequence that is open to empirical validation. However, a variety of studies (coupled with our own experiences) indicate that the hierarchical approach is probably the most effective way to begin the planning of your course.

Creating the Hierarchy

Conceptually, the creation of the hierarchy is a response to a single question asked over and over after each answer. *The Question* is:

> What must the learner be able to do if told to perform a task, but has been given no specific training in the task?

Practically, to answer *The Question*, we recommend the following procedures:

- Find a room with a large table or bulletin board.
- Secure a package of index cards.
- On the first index card write down your overall goal for the course.
- Ask yourself *The Question*.
- Write down each answer to *The Question* (there is usually more than one answer at this stage of analysis) on an individual index card and center these cards horizontally under the first index card.

- Take what appears to be the easiest topic to analyze from among each of the cards in step five and ask yourself *The Question*. Place the cards that answer *The Question* horizontally under the appropriate card.
- Take what appears to be the easiest topic to analyze from among each of the cards in step six and ask yourself *The Question*. Place the cards that answer *The Question* horizontally under the appropriate card.
- Continue this process until you have reached a point where the students may begin instruction with their present skills.
- Repeat steps six through eight until the hierarchy is completed for each of the cards identified in step five.
- After the first draft of the hierarchy, carefully copy the hierarchy if you can't leave it on the wall or the table.
- Forget the whole experience for at least 24 hours.
- Ask someone with good analytical skills to meet with you for an hour and a half. Take them to the room, explain what you are trying to do, and then show them the hierarchy you have created. Ask them to react to your analysis. (At this stage you will probably need to move the index cards around as new perspectives ebb and flow. You may also discard or add new cards.)
- Save this hierarchy and use it to create the first draft of your course. Figure 1.3 summarizes this process.

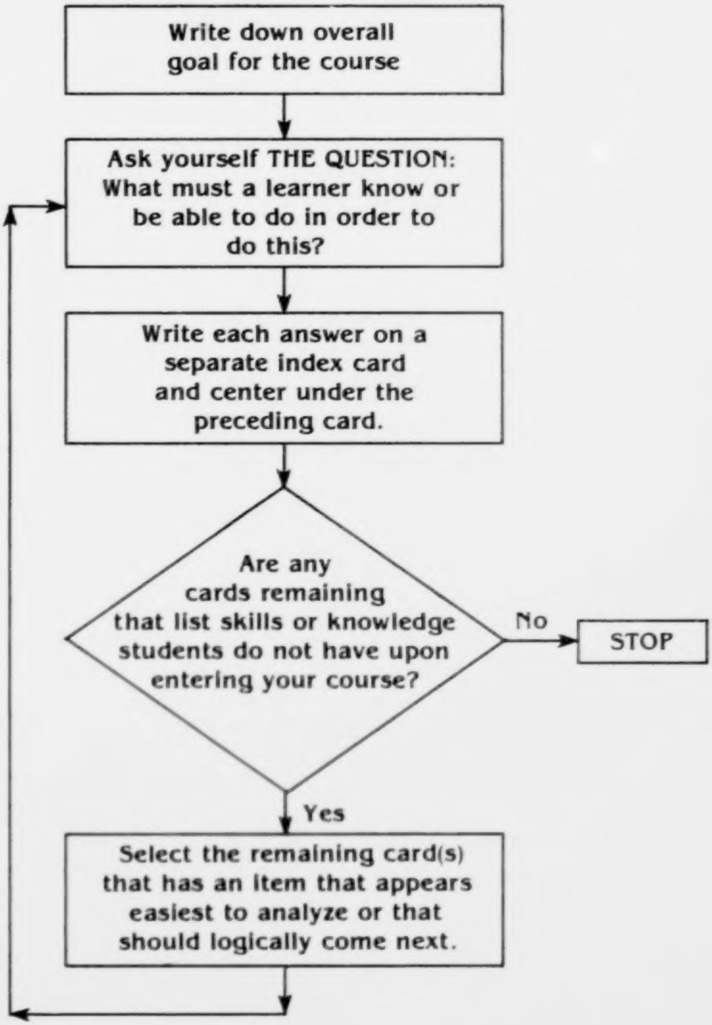

Write down overall goal for the course
Ask yourself THE QUESTION: What must a learner know or be able to do in order to do this?
Write each answer on a separate index card and center under the preceding card.
Are any cards remaining that list skills or knowledge students do not have upon entering your course?
No
STOP
Yes
Select the remaining card(s) that has an item that appears easiest to analyze or that should logically come next.

Figure 1.3. Summary of procedures for creating the hierarchy.

Hierarchy Examples

We have found that examples of this process are useful in understanding the approach. Listed below are three hierarchical analyses. The first two were developed for an entire course, the last one for a portion of a course.

PRODUCTION-OPERATIONS MANAGEMENT

This course is a three credit course serving approximately 250 students a semester. This course is a requirement for many business majors and introduces them to procedures used to plan, schedule, and control the production of goods or services. It is by nature a very quantitative course.

On the first index card we wrote the overall goal of the course:

> Students will be able to formulate a production plan for a production-operations management problem (Step 3).

We asked *The Question* (Step 4) and wrote down the answers to this question on three separate index cards (Step 5). These cards were:

- Be able to forecast demand for a product or service.
- Be able to calculate the optimal level of workforce to meet the demand.
- Be able to calculate the optimal inventory to meet demand.

In this case, there is a logical sequence to the way that these activities are performed in practice. That is, a demand forecast is usually developed before the other two. Thus, we began with Forecasting, and asked *The Question*. We wrote the answers to this question on three separate index cards (Step 6). These cards were:

- Be able to calculate a moving average.
- Be able to apply exponential smoothing.
- Be able to calculate a regression equation.

In this case, there was a relationship between 1 and 2 in that exponential smoothing is a variation of a moving average. Thus we started with moving average as the easiest component to analyze and asked *The Question*. We wrote the answers to this question on two separate index cards (Step 7). These cards were:

- Be able to calculate a simple moving average.
- Be able to calculate a weighted moving average.

From this list, we saw that both "simple" and "weighted" moving averages were dependent on a single skill. This skill was most likely the minimum skill level that we would need to teach to these students and we thus decided to end the analysis at this point (Step 8). We wrote down the single answer to *The Question* for both of these skills. This card was:

- Be able to calculate a simple average.

We decided "regression" would be the next easiest topic to analyze and continued with the analytical process (Step 9).

The final hierarchical analysis for our course is shown in Figure 1.4.

For the Production-Operations Management course the hierarchy was built in two directions. It proceeds from the most basic unit at the bottom of the hierarchy to the most complex, comprehensive unit at the top. We have also placed the most basic components of the production plan on the left side and have proceeded to the more complex issues on the right. Using this procedure we find that forecasting techniques are crucial to understanding aggregate planning, and that both forecasting and aggregate planning are needed to understand inventory control.

COLLEGE STUDY SKILLS AND READING

This course is a 2 credit hour course designed to improve college students' reading skills with special emphasis placed on developing more effective study habits, vocabulary development, comprehension improvement, and content textbook reading skills. It is required for entering students who score below a certain point on a standardized test of language skills. It enrolled 100 students a semester. Figure 1.5 is the hierarchical analysis for this course.

THE ART OF PUBLIC SPEAKING

This course is a three credit course that is a part of the required General Studies courses. Each class is comprised of approximately 30 students from a variety of backgrounds. However, most students in the class have had no experience with public speaking.

The hierarchical analysis shown in Figure 1.6 is for a part of the course. The goal of this part is that students be able to present to the class an introduction to a speech using established speech principles.

To give a good introduction to a speech the students will first need to know four areas:

- Common performance techniques.
- Brainstorming strategies for preparing the topic.
- The objectives of an introduction.
- Audience analysis techniques.

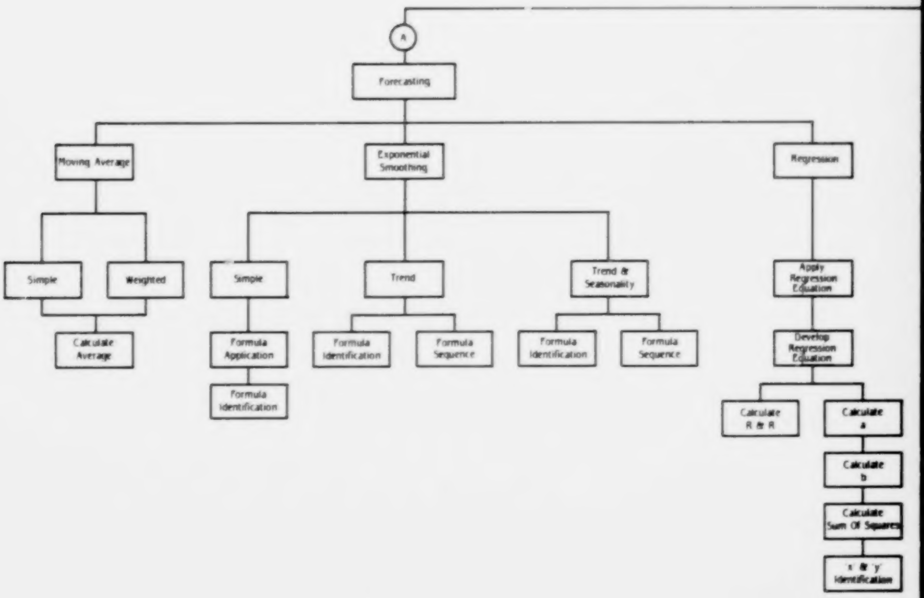
Further analysis focusing on the objectives of an introduction indicates there are four aspects of a good introduction:

- Establishment of the speaker's credibility.
- Arousal of the audience's attention.
- Revelation of the topic.
- Preview of the body of the speech.

An analysis of "arousal of the audience's interest" indicates that there are two main components to this aspect of a good introduction:

- The introduction should be relevant to the audience.
- An appropriate technique should be chosen to garner attention.

Finally, these two components "relevance" and "techniques" can be further analyzed as is shown by the lowest level in Figure 1.6.


A
Forecasting
Moving Average
Exponential Smoothing
Regression
Simple
Weighted
Calculate Average
Simple
Formula Application
Formula Identification
Trend
Formula Identification
Formula Sequence
Trend & Seasonality
Formula Identification
Formula Sequence
Apply Regression Equation
Develop Regression Equation
Calculate R & R
Calculate a
Calculate b
Calculate Sum Of Squares
'x' & 'y' Identification

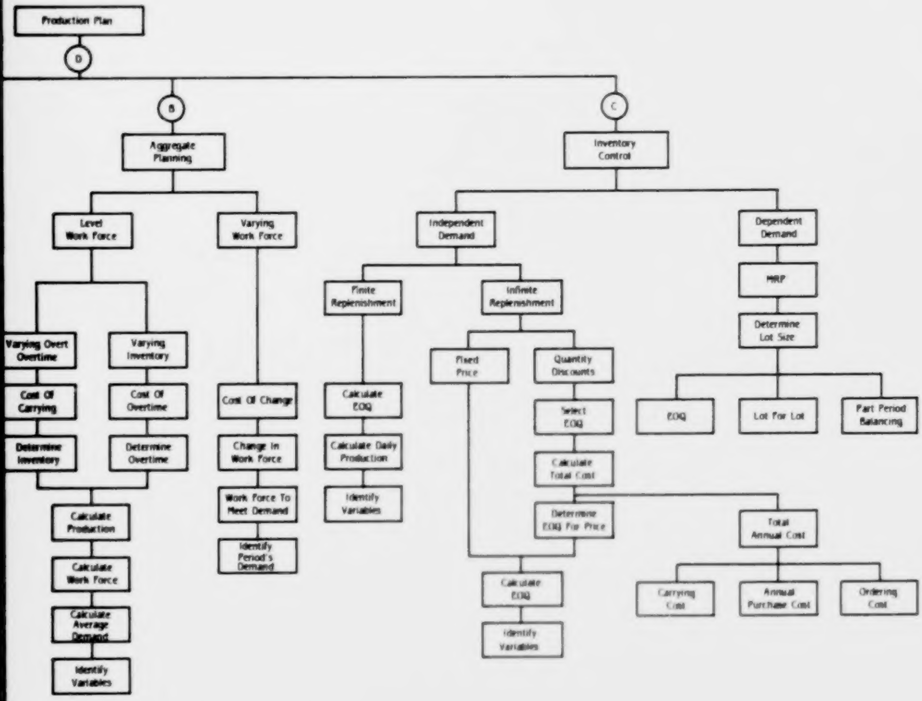


Figure 1.4 Hierarchy for Production-Operations Management Course

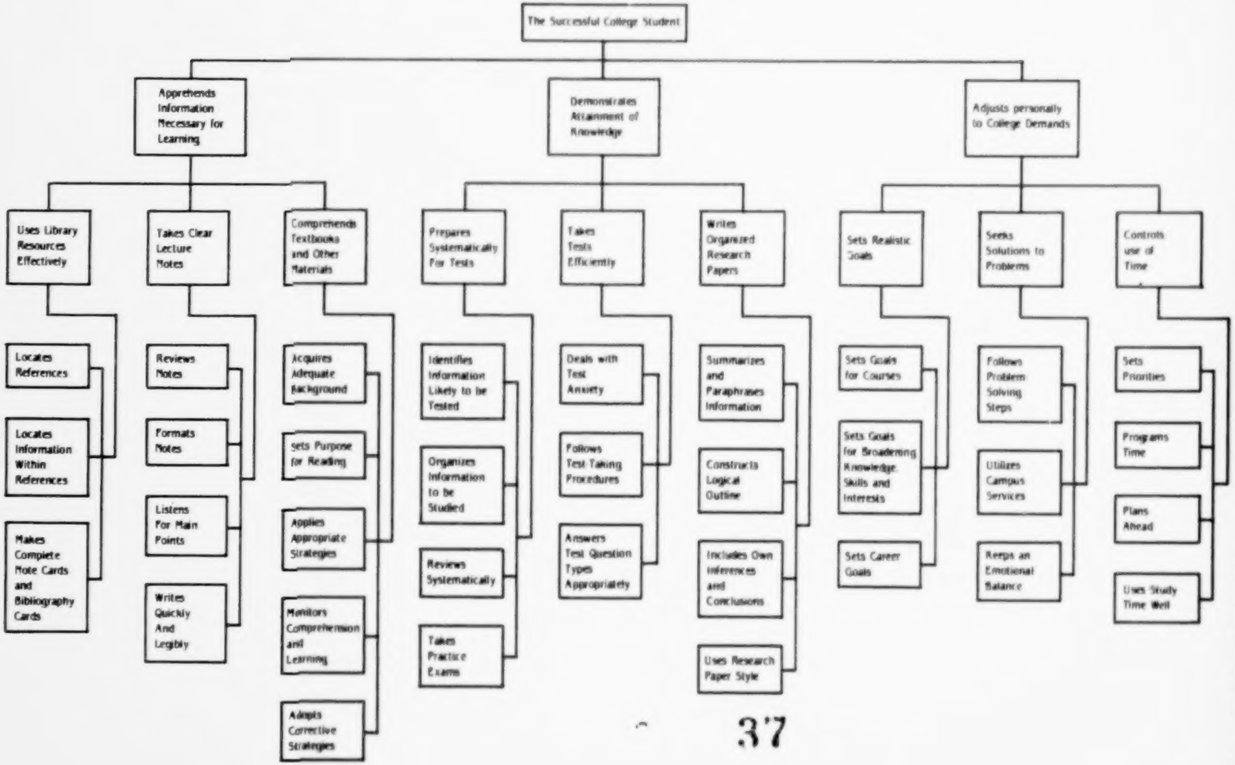

The Successful College Student
Apprehends Information Necessary for Learning
Demonstrates Attainment of Knowledge
Adjusts personally to College Demands
Uses Library Resources Effectively
Takes Clear Lecture Notes
Comprehends Textbooks and Other Materials
Prepares Systematically For Tests
Takes Tests Efficiently
Writes Organized Research Papers
Sets Realistic Goals
Seeks Solutions to Problems
Controls use of Time
Locates References
Locates Information Within References
Makes Complete Note Cards and Bibliography Cards
Reviews Notes
Formats Notes
Listens For Main Points
Writes Quickly And Legibly
Acquires Adequate Background
Sets Purpose for Reading
Applies Appropriate Strategies
Monitors Comprehension and Learning
Adapts Corrective Strategies
Identifies Information Likely to be Tested
Organizes Information to be Studied
Reviews Systematically
Takes Practice Exams
Deals with Test Anxiety
Follows Test Taking Procedures
Answers Test Question Types Appropriately
Summarizes and Paraphrases Information
Constructs Logical Outline
Includes Own Inferences and Conclusions
Uses Research Paper Style
Sets Goals for Courses
Sets Goals for Broadening Knowledge Skills and Interests
Sets Career Goals
Follows Problem Solving Steps
Utilizes Campus Services
Keeps an Emotional Balance
Sets Priorities
Programs Time
Plans Ahead
Uses Study Time Well

Figure 1.5. Hierarchical analysis for College Study Skills and Reading Course.

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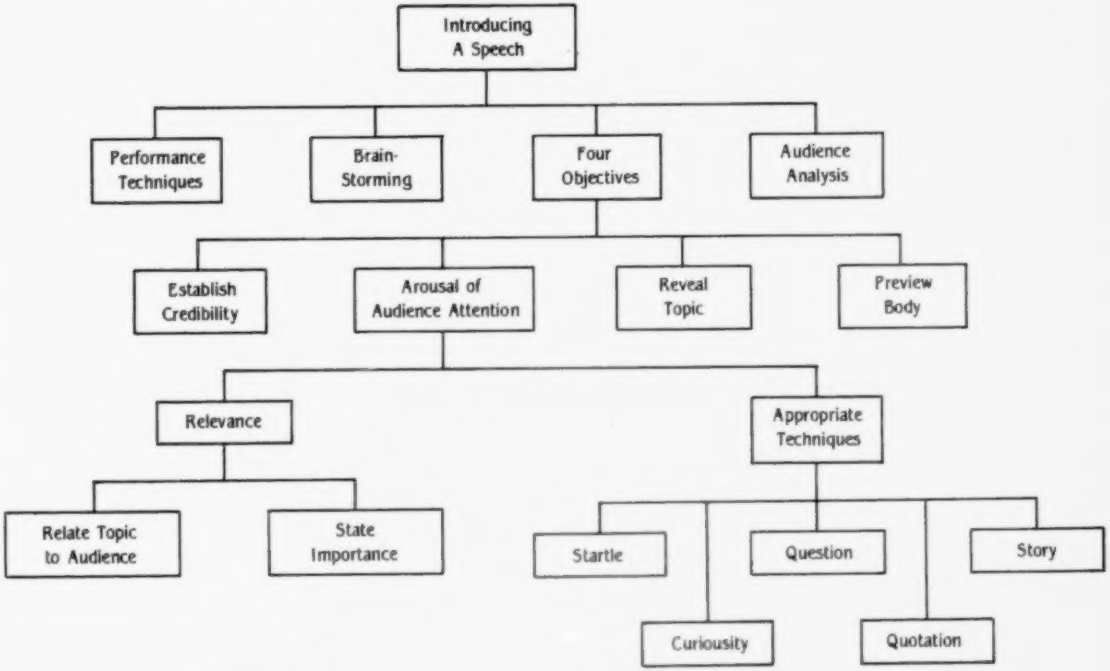

Figure 1.6. Hierarchical analysis for the course unit: Introducing a Speech

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PLACEMENT OF GUIDED DESIGN PROJECTS

Each Guided Design project will require students to apply material they have learned in order to solve a decision-making problem. These projects represent synthesis activities that combine and reinforce the content material. They will have the greatest impact if they are scheduled when students have completed a major unit of the content. The major units of content are easily identified once you have completed the hierarchical analysis.

If you return to Figure 1.4, the hierarchical analysis for our Production-Operations Management course, you should be able to see how this analysis points directly to the proper placement of group projects. The group exercises are best placed at the intersection of component parts for a given task, e.g., in a forecasting problem one would place the group exercise at the intersection established by joining the content of moving averages, exponential smoothing, and regression analysis. At this intersection the students have learned the content necessary for approaching the group problem-solving exercise in the limited context of forecasting decisions. Similarly, the group exercises can come at the confluence of aggregate planning component parts and inventory control parts. Thus, conditions are established wherein the student gains both content and problem-solving experience in each segment of the overall course structure. It also becomes logical to insert the final course exercise at the confluence of the larger components. In Figure 1.4, A, B, C, and D represent the placement of group projects within the content structure of the course.

In Chapter 3, we will go on to describe exactly how to write these projects. As of now, though, you should be able to develop a map for your course that will indicate how many Guided Design projects you should have, when they should occur, and the content material they should cover.

CHAPTER 2

DEVELOPING INSTRUCTIONAL UNITS

Introduction
Rationale
Statement of Skills
  The Verb
  The Content
Content Presentation
  The Dimensions of the Skills Statement
  The Instructional Sequence
  Style
  Writing the Instruction
Testing
  The Pretest
  The Embedded Test
  The Practice Posttest
  Posttest

Introduction

In the Guided Design approach the majority of class time is reserved for group work. We feel it is important that the instructor be available to supervise, facilitate, and provide feedback to the student groups. As a result, we have abandoned lectures as the primary means of information transmission because they would all but eliminate any opportunity to work with the groups. Lectures are effective for motivation and dealing with a tough concept that seems to stump everybody (see *Lectures* in Chapter 5) but they are inefficient and ineffective when compared to self-instruction strategies.

For the Guided Design strategy to work optimally students must learn the content outside of class time. This can be done most effectively with self-instruction materials. These materials can be delivered using print, computer, or audiovisual media. How they are delivered is less important than the fact that they must be developed following a systematic procedure that will guarantee that students possess the prerequisite skills prior to attempting to solve the group project problem.

Once you have completed the map for the course (see *Hierarchical Analysis*) you can then begin to develop the self-instructional materials. Many people panic at this stage, but if you have a good hierarchical analysis, the instructional materials can be written fairly easily. Just as a boat builder has templates to assure the proper curve of the hull, you can use an instructional template to build a worthy instructional unit. In this chapter we will introduce you to one such template. It is based on a number of studies that have shown it to be an effective approach to the design of instruction. Our own experience with this model also convinces us of its worth. Using the model each lesson segment would include:

- A rationale designed to illustrate the importance of the unit to the student.

- A pretest to assess entry level skills.
- A statement of the skills we expect the student to gain from the unit.
- For each of the skills statements, the instructional unit should include:
    - a) a clear statement of the concept, rule, and principle that we expect them to learn.
    - b) an elaboration and/or clarification of the rule or concept.
    - c) a series of examples and non-examples that illustrate the concepts or rules.
    - d) a discussion of why a given example does or does not illustrate the proper application of the concept or rule.
    - e) a practice component where the learners can practice their mastery of the skill.
    - f) a feedback section where students are shown the correct answer to the problem with a discussion of why it is the correct answer.

In this chapter we will introduce this model and show how it can be used to develop self-instruction materials so that students can master the basic content and skills they will need to attack the group projects.

RATIONALE

Perhaps one of the hardest tasks we face as teachers is being dared to answer the question, "So what?" There are few things quite as bad as a classroom filled with students hostile to your course and enrolled in it simply because "it's required." Unfortunately, required courses are often seen as detracting from one's education rather than contributing to it. However, the best of all possibilities is that schooling and education work in unison, not in contradiction. One of the best ways to establish this unison of schooling and education is to demonstrate the relevance of your course to concrete settings. When this happens students are more likely to be motivated and, when motivated, learning is faster and more enjoyable.

We try to establish relevance in the course on two levels: a macro and a micro. At the macro level we attempt to assure that all projects represent problems that would be encountered in the field. In Production-Operations Management this might entail problems associated with forecasting demands. In art, it might focus on the problems of attribution (determining who the painter was). In archaeology it could deal with interpreting a culture through the artifacts found in a dig. At the micro level (which is what this section is about), we try to show how the smaller parts of instruction are important to master these larger goals. Sometimes a unit will stand alone and can thus be seen as relevant in and of itself without reference to the "big picture"; sometimes you will need to tie it into the "big picture."

The *Rationale* is thus placed at the beginning of each major unit and can be accomplished in the space of a paragraph or two (at the most). For example, you could begin a unit on the use of small claims court by stating:

> This lesson is about the small claims court system in our country. This branch of the legal system is different from our state court systems and the federal court system in that you can file lawsuits without a lawyer provided your lawsuit doesn't exceed a certain amount (usually $500-$1,000).

or you could present it like this:

> It's two weeks after you have moved into a new apartment. A letter arrives from your old landlord. Expecting to get back your $250 security deposit, you joyfully tear open the envelope. Inside is a form letter explaining that your apartment wasn't clean enough and your deposit isn't being returned. What can you do? Nothing? Wrong. You can file a lawsuit against your landlord without ever seeing an attorney and have the issue decided by a judge.
>
> *(Lucas, 1983, p. 160)*

You should see the difference between the two. Most students will react to this second example positively because it is directly tied to their experiences. To be sure, not every unit will have a sparkling rationale, nor will every item of instruction be perfectly relevant to the student; but as a rule a good rationale will go a long way toward answering, "So what?"

STATEMENT OF SKILLS

If you think back to your own days as a student you can probably remember lectures where the professor was the only one who seemed to know what the point of the lecture was. You probably found yourself wondering privately what was going on, then asking a classmate, and finally tuning out to read the campus newspaper (in large lecture) or doodling (in small classes). These instances are all too common and often come as the result of the student (and sometimes the instructor) not knowing what is important and what isn't. The first step to remedy this situation is to provide a clear and unambiguous statement of what the learner should be able to do at the end of instruction.

As we mentioned, the *Statement of Skills* should be a clear statement of what skills the learner should have at the end of the instructional unit. Quite literally, books have been written on writing these statements. This seems to be overkill for our purposes. Rather, we would suggest that you can develop your skills statements with two components: the verb and the content.

The Verb

The verb is the most critical part of the skills statement. It describes in observable terms what the learner will be able to do. The emphasis here is on the word "observable." If you feel that students should be able to "appreciate art" you really haven't told the students what they should be able to do. "Appreciate" is open to many interpretations. On the other hand if you told the students they should be able to "identify the elements of balance and perspective" then there is less ambiguity about what is to be done. In this latter instance, we have operationalized the term "appreciate" and have thus reduced the level of ambiguity. The verbs you use will depend on the level of learning involved, e.g., "state" for factual information, "classify" for concepts, or "apply" for rules. (These levels of learning are discussed in the next section, *Content Presentation.*)

The Content

If the verb describes what the student is to do, the content portion describes the material on which an action is to be done. If the verb is "to list" then the content area might be "the steps of Guided Design." If it were "to identify the elements of balance and perspective" then the content might be "in post-impressionist art." For your instructional units the content for the verbs will be found from the components identified by the *Hierarchical Analysis.*

CONTENT PRESENTATION

In 1977 Gerry Faust wrote an article entitled "Selecting instructional strategies: or once you've got an objective, what do you do with it?" It was, and still is, a reasonable question. His article went on to outline a set of procedures for teaching an objective (or statement of skill). These procedures were developed by a team of instructional designers and represent the basic steps in what is now called Component Display Theory (CDT) (Merrill, 1984).

The procedures of CDT are derived from learning theory and are useful for many instructors in that they make explicit most of the activities a good teacher uses to ensure learning (and can thus serve as a guide or checklist when designing instruction). Listed below are the procedures you would use to implement a modified CDT system for each of your skills statements.

The Dimensions Of The Skills Statement

If you examine your list of skills statements you will probably find that you have identified a range of learner activities that may begin with memorization and extend to problem solving. However, most of the types of learning that you will encounter can be described by two dimensions: the task to be performed, and the type of learning. The task dimension is divided into two levels:

- Those tasks the student must memorize or remember.
- Those tasks that are to be used or applied.

The type of learning is divided into five categories:

Facts—simple associations between names, objects, symbols, etc. (Facts can only be remembered or memorized, they are not applied or used).

Concepts—Categories or classifications defined by a common set of specific characterists.

Procedures—a sequence of steps or operations to be performed on a specific characteristics.

Rules—and ordered sequence of steps or operations that can be applied to a class of objects.

Principles—explanations or predictions of why things happen based on cause-effect relationships.

Figure 2.1 summarizes the relationship between the type of task and the type of learning. It also illustrates typical skills statements for each combination.

TASK	LEARNING				
	Fact	Concept	Procedure	Rule	Principle
Remember	TSWBAT* state the year of the Battle of Hastings.	TSWBAT list the attributes of a revolution.	TSWBAT list the procedures for footnoting according to the Turabian style manual.	TSWBAT state the steps for converting an improper fraction.	TSWBAT state Newton's Third Law.
Use		TSWBAT classify an historical event as being a revolution or not a revolution.	TSWBAT write a footnote using the Turabian manual.	TSWBAT convert an improper fraction.	Using Newton's Third Law, TSWBAT analyze a situation involving physical actions and predict and explain the outcome.

* The student will be able to.

Figure 2.1: Relationship of Task and Type of Leraning including Sample Skills Statement

Since most Guided Design instruction focuses on the "Use Concept, Rule, or Principle" levels of learning, we will limit our discussion to these areas.

CONCEPTS

Concepts refer to groups that share a common set of characteristics. Concept learning can apply to objects, events, or ideas. Concepts typically involve sorting or classifying an instance as a function of its critical attributes, e.g., size is not a critical attribute of the concept circle but roundness is. A skills statement for "Use Concept" might use the following structure:

	sort				
	recognize		idea		characteristics
The student will	classify	a(n)	event	according to its	features
	categorize		thing		definition
	choose				

RULES

Rules refer to a sequence of steps for identifying or transforming an idea or entity. To determine if a pitched ball is a strike requires a rule of identification. An umpire must use a rule that takes into account the location of the ball with respect to the batter, the batter's response to the pitched ball, the result of that response, and the count on the batter. Converting an improper fraction or calculating a trajectory for orbit are examples of rules of transformation in that they convert one thing (in this case numbers) into another thing (another type of number). A skills statement for "Use Rule" might use the following structure:

	law		solve
	rule		convert
Using the	formula	of (a given content area) the student will	determine
	steps		prove
	process		calculate

PRINCIPLES

Principles involve explanations of why or how things happen. Principles are based on cause-effect relationships, theories, physical laws, etc. Principles are typically invoked to explain why something may or may not happened, what is likely to happen, or why something isn't working. An historian seeks and uses principles to understand why a revolution may or may not occur. An engineer may draw on hydraulic and physical laws to explain why an airplane landing gear failed to descend. Principles are taught because they allow us to deal with a variety of situations, events, effects, etc. Instead of having to learn about or anticipate every possible situation the principle will summarize the "how" and "why" of general situations in order to deal with a given specific. A skills statement for "Use Principle" might use the following structure:

Given (a specific situation) the student will
analyze
predict
explain
evaluate
diagnose

The Instructional Sequence

CDT uses an instructional sequence that is very similar for each of the types of learning with which we are concerned. We use six steps in our instructional sequence: presentation of the skills statement, elaboration, examples, help, practice, and feedback. While there are differences in what is presented (as a function of the type of learning) there is a consistency in how the information is presented. We have found that this consistency helps the students move through the material and we consider it an important part of the design of the self-instruction package. See Figure 2.2.

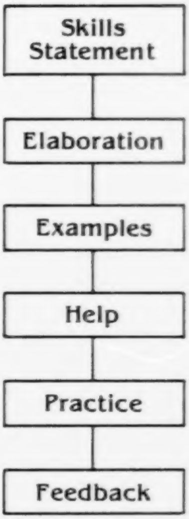


Figure 2.2 Summary of steps in the instructional sequence.

PRESENTATION OF THE SKILLS STATEMENT

Each segment of instruction should begin with a clear statement of the concept, rule, or principle that you expect the student to learn.

- Concepts should present all critical features of the concept.
- Rules should present all steps in the correct order.
- Principles should present all causes, effects, and relationships.

ELABORATION

The skills statement you have presented may be clear enough to stand alone or may require additional discussion. The purpose of the Elaboration is to highlight special aspects associated with the skills statement that you feel may be of importance to the students. This may include such activities as:

- Clarifying terms that may be new to the student.
- Identifying especially important features.
- Explaining why something is done or how it works.
- Restating the skills statement or drawing an analogy that applies to understanding the statement.
- Providing mnemonics to help the learner remember the statement.
- Explaining how it came about, how it fits into the course, or how it links with something the student may already know.
- Representing the statement with pictures, symbols, flowcharts, tables, etc.

EXAMPLES

Examples are a very powerful and thus important part of an instructional strategy. A few good examples can often make the difference between insight and misunderstanding. In developing the Example component of your instruction you should try to select examples that have certain characteristics:

- Examples should include all critical aspects.
- The first examples should be easiest to understand and then proceed to the more difficult.
- A good series of examples will anticipate common mistakes.

There should be enough examples to illustrate each of the critical components of the skills statements, e.g., each of the attributes in a concept, each of the steps in a rule.

HELP

The Help is similar in nature to the Elaboration in that it provides the learner with additional material concerning a component of the lesson. Helps will vary according to the types of learning involved but they share some of the following characteristics:

- They highlight critical parts of the example, i.e., they show why an example does or does not illustrate a particular point.
- They may involve the use of simplified representations or procedures that relate to the given example.
- They may give additional hints as to how to apply the skills.

PRACTICE

The Practice part of the instructional unit should provide the student with a chance to test his or her knowledge. In the section on *Testing* we will discuss the use of embedded tests. The embedded test and the Practice component are one and the same. These items should follow standard rules of test construction. In addition:

- Items should proceed from easy to hard.
- Items should parallel those placed on the exam.
- Items should test for common mistakes.

Figure 2.3 illustrates three typical question types.

Sample Test Questions
for
Use: Concept, Rule, and Principle

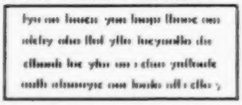
LEARNING		
Concept	Rule	Principle
Read the following summary of the Vietnam conflict.  According to Churchill, was this conflict a revolution?	Convert the following fractions: 3 1/3 2 1/7 8 4/10	If a fan is placed on the stern of a boat and blows air into the sail will the fan propel the boat?

Figure 2.3. Sample test questions.

FEEDBACK

This final aspect of the instructional strategy should provide the student with information on his or her performance. Again, the philosophy here is that testing can and should be a part of the learning process. To this effect, we feel that feedback on the embedded test items is an important part of the overall learning process. Feedback should:

- At a minimum, provide the student with the correct answer to the test item.
- At the maximum, provide complete remedial instruction for missed items.

Figure 2.4 summarizes these aspects. Figure 2.5 graphically represents them.

Style

As with any written work there is value in establishing and following a particular style. Instructional work is no different and in fact demands the use of a consistent style to aid learning. The style issues identified by CDT are separation, identification, and clarity.

SEPARATION

Each of the components of the lesson, e.g., Statement of Skills, Examples, Elaboration, etc., should be clearly separated from each other. This can be done by:

- Setting off the component with a box.
- Using different colors, typefaces, underlining, etc.
- Placing a new component on a special part of the page or beginning it on a new page.
- Pausing when delivering information orally, e.g., lectures.
- Using blank space when delivering information through print or electronic text.

IDENTIFICATION

The student should be able to recognize quickly the purpose of a given component. This can often be done through titles such as:

Definition of . . .	Procedure for . . .
Key Point . . .	Examples . . .
Test your understanding . . .	

Figure 2.4 Summary of Instructional Sequence Components

PRESENTATION COMPONENT	TYPE OF LEARNING		
	Concept	Rule	Principle
Statement	All critical features of the concept.	All steps listed in correct order: symbols defined for formulas.	All causes, effects, and relationships.
Elaboration	1. *Clarify terms.* 2. Identify especially important features. 3. Explain why something is done or how it works. 4. Restatement of skills statement or use of analogy. 5. Giving a MNEMONIC (memory trick). 6. Giving a general example of how the statement can be used. 7. Explaining why the statement is important. 8. Explaining how it came about, how it fits in the course, or how it relates to something the student already knows. 9. Explaining some of the terms in the statement. 10. Representing the statement with pictures, symbols, flowcharts, tables, etc.		
Examples	Examples show all critical characteristics; non-examples show lack of critical characteristic(s).	Application shows use of steps of formulas in proper sequence.	Interpretation is clearly linked to causes, effects, and relationships.
	At least one example-non-example for each critical characteristic	At least one example for each important step. Examples for all possible branches or decisions.	
	.... Examples should proceed from easy to hard		
	.... Examples should anticipate common mistakes		
Help	Highlight the critical characteristics of an example.	Explain why each step is done.	Highlight important features.
	Explain why or why not something is classified as a member of a concept.	Explain why each step is important.	Simplify the relevant information from the case study in which it is embedded.
	Show the use of a check-list or heuristic to help classify.	Give additional information about how to perform the task.	Use logical representations of the IF-THEN relationships.
	Simplify early examples, e.g., use line-drawings instead of complicated photographs.	Give additional information about how to know if you've done it wrong.	Give additional information about how the principle applies, or why it doesn't.
		Give flowcharts, tables, etc.	Give hints as to how to analyze problems.
Practice	Test to classify a new instance.	Test to apply as many branches of formulas possible.	Test with a variety of situations.
	.... Items should parallel those placed on exams		
	.... Items should proceed from easy to hard		
Feedback	.... At a minimum, provides only the correct answers		
	.... At the maximum, provides complete remedial instruction		

CLARITY

Each of the components must be presented in a straightforward manner. This means attending to the content presented as well as the language used. Clarity entails using:

- The appropriate reading level for the learner.
- Conciseness in the presentation. The instruction should never be confusing, wordy, or vague.
- All essential information should be present—students should not have to go to other places to get information.

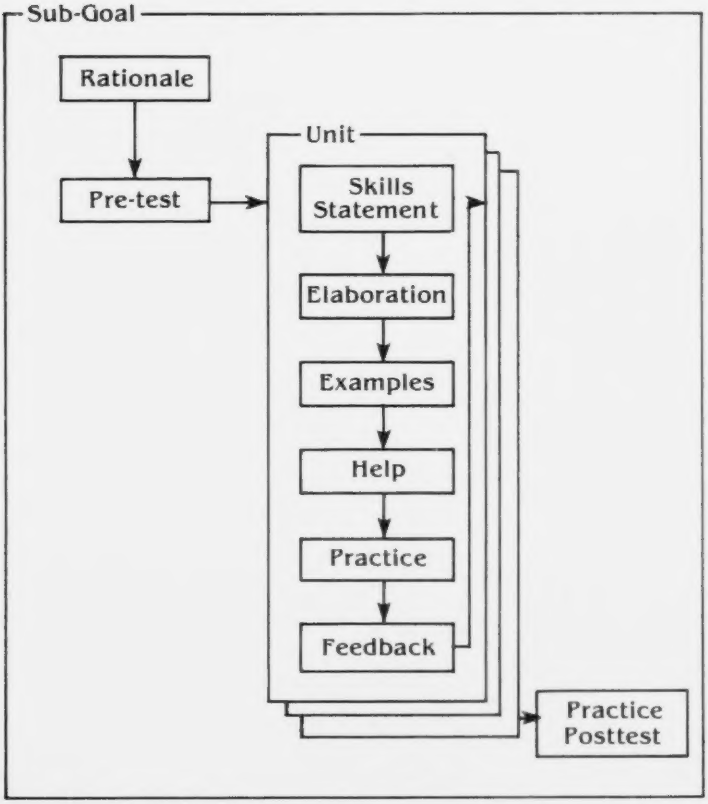


Figure 2.5 Graphic representation of an instructional sequence.

Writing the Instruction

At first glance it would appear that writing the self-instruction unit will take you the better part of a lifetime. In fact, if you consider that the CDT materials were originally developed for a large computer curriculum project involving a number of staff members you might be tempted to quit before beginning. Don't. We have provided an overview of this process to describe an ideal. In reality, you probably won't have the time or money to develop units to this extent. However, if you get the time you can probably write a reasonably complete self-instructional guide for a three-credit college course in six weeks.

We suggest you begin by writing a lean version of the ideal unit. As students use the materials you will soon find the areas that need work. At that point, you would then go ahead and add more examples, helps, etc., as necessary.

TESTING

The scene is familiar:

> You have just finished presenting an important but difficult concept to your class. From past history you know that many people will have trouble grasping the ideas you presented. You ask, "Any questions?" A few heads nod indicating no questions. You ask, "Are you sure?", a few more heads nod indicating certainty. At mid-term a noticeable proportion of the class misses the questions on the concept. If you ask the students what happened they will probably say something like, "I don't know. It made sense in class, but I just couldn't answer the questions."

The student's lament is all too common. However, by employing four basic types of testing strategies we can:

- Help students move through material they may already know,
- Give students feedback on material they are currently learning,
- Help them to see if they have mastered the material they have studied,
- Assess their knowledge of the material

The Pretest

The first type of test our students encounter is a unit pretest. This test has two purposes: to alert the student to what is to follow and to help the student determine how much of the unit's material may already have been learned. (If the student passes the pretest for the unit we encourage them to merely read through the unit and then move on to the next unit). The pretest items are developed based on the *Statement of Skills* for that unit and precede all instruction. Correct answers are listed in the back of the manual or near the pretest itself.

The Embedded Test

The embedded tests are an integral part of the self-instruction units. After every major concept or principle is discussed and illustrated there is an embedded test. (The embedded test usually matches the "Practice" component of the instructional sequence we just discussed) This test is rarely more than two questions. The intent here is to provide the student with an opportunity to apply what has been taught and to give the student feedback on his or her response.

An important physical characteristic of the embedded test in our self-instruction units is that the question is always posed on one page and the answer ("Feedback" in the instructional sequence) placed on the back side of the next page. (We don't place the answer on a facing page as that would be tempting fate—there is a real psychological barrier to turning over a page for an answer compared to just glancing at it on a facing page.) We stress to the students that these tests are there to help them, that research has shown more learning occurs when a written response is made rather than just thinking about the answer, and that they are cheating themselves if they turn the page over to see the answer before trying the problem. We have also found that students respond well to this admonition (probably because it works).

The Practice Posttest

The practice posttest comes at the end of the instructional unit. This test is based on the same *Statement of Skills* as the pretest. As a result, it will look just like the pretest except that it will contain different test items to assess the skills, e.g., if the *Statement of Skills* indicated that the student should be able to multiply any two two-digit numbers, then the pretest might ask the student to multiply 29 x 43 while the posttest might ask for 45 x 56. If the *Statement of Skills* indicated that the student should be able to analyze a historical setting and identify the factors that existed in support of the Theory of Rising Expectations, then the pretest might ask the students to read a description of events leading to the French Revolution while the posttest might have a similar description for the American Revolution.

Posttest

The posttest is developed in the same manner as the pretest and practice posttest. Philosophically, however, it is quite different from these tests. Where all the other testing is designed to help the student determine whether or not he or she has learned the material and remains ungraded, this test will be graded. Test questions are chosen from the material and administered in a traditional hourly test session. (See *Grading* in Chapter 5). Correct answers are available as with the pretest.

CHAPTER 3

GROUP PROJECTS

Introduction
Project Content
  Developing a Guided Design Project
  Some Guidelines for Developing the Project
Writing the Project
  The Instructions
  Common Errors
  Feedback
  Combining Steps

Introduction

Group projects are an essential part of a Guided Design course. Not only do students learn the steps of decision-making and how to apply their content knowledge to realistic problems, but they also learn how to work with each other. For this reason, it's essential that a properly developed Guided Design project consider two phases: determining the project content and then actually writing the project.

After completing the hierarchical analysis you will already be a long way toward knowing what the content of each project should be. However, you are still faced with the problem of determining a setting and context for that material. The first section of this chapter presents some ideas along those lines.

Actually writing the Guided Design project also requires some careful consideration. In the second part of this chapter we present some ideas that you may want to consider for reducing or increasing the number of instruction/feedback steps.

PROJECT CONTENT

We mentionied previously (PLACEMENT OF GUIDED DESIGN PROJECTS) that each Guided Design project should occur at a time when students have reached a confluence of component parts in the hierarchical analysis. At this point, the project will fulfill a need on the part of students to put their learning into practice. They will also have enough knowledge to make meaningful decisions. However, the Guided Design projects must also be carefully designed in other ways.

Developing a Guided Design Project

Before you start developing the projects, you should take a look at the hierarchical analysis and list the content material that the project should cover. If you've done the hierarchical analysis correctly, then these items should all fall within a common topic area. In general, we try to be sure that the project covers all this content material in one way or another. For example, referring back to Figure 1.4 you can see that the first project in our Production-Operations Management course covers the forecasting material. That project requires students to use regression analysis and either exponential smoothing or moving averages. In the latter case, they must justify their choice. Thus, they are required to at least consider using all the material that had been learned about forecasting.

As you begin writing the project itself, you can think of developing a Guided Design project as an open-ended problem; something that can be dealt with through the steps of decision-making. In fact, you may wish to go through the decision-making outline as you develop the Guided Design project. We've found that doing this not only helps in terms of being a good sequence of steps to follow, but having the same steps that the students will be following in front of us often helps us to see ways that the project can progress. A project outline is shown in Figure 3.1 for your convenience. Figure 3.2 is a list of important considerations for each stage in a project. Figure 3.3 is a sample outline for an anthropology project. Figure 3.4 is the start of the outlined project.

Project Outline

Situation

Goal of the
Project Work

Component Analysis

Possible Solutions

Constraints

Gather
Information

Choose

Analysis

Synthesis

Evaluation

Figure 3.1. Project Outline. Reprinted with permission of Wales, C.E. and Nardi, A.

Situation	Describe the setting and the open-ended problem which must be solved. If new concepts are to be learned in conjunction with this project, the situation should provide an appropriate setting for their use.
Goal of the Project Work	State the goal of this decision-making project. When the project is completed. What will be the result?
Gather Information	What information is needed to proceed with the problem situation and where can it be obtained? This step may require additional study, or it could simply mean organizing the background information available for the project work. (Note that while this step often occurs here, it could occur somewhere else or as part of other decision-making steps.)
Possible Solutions	List three or more ways to achieve the goal of the project.
Constraints	List the factors which limit what can be done. In many cases, the constraints serve as the criteria for evaluating the possible solutions.
Choose	Using whatever criteria have been identified, evaluate and rank the possible solutions. Before a solution is chosen for further work it should be tested for both positive and negative consequences.
Analysis	Dissect the chosen solution and identify the important factors that must be considered when a detailed solution is developed in the synthesis step. This list of factors may take the form of a series of questions which must be answered in the synthesis step (who, what, when, where, how).
Synthesis	Combine the factors identified or the answers to the questions asked in the analysis step and produce a detailed solution. (Note that the Feedback here may include a "model" solution, or be left incomplete, or be omitted entirely, so the learners are on their own.)
Evaluation	Describe either the evaluation of the solution or the way in which an evaluation could be performed.
Recommendations	Recommend an appropriate course of action.

Figure 3.2. Considerations for Each Stage in a Project. Reprinted with Permission of Wales, C. E. and Nardi, A.

Situation	Exchange students help an anthropologist try to solve the problem of kwashiorkor, a severe protein deficiency in the face of powerful food taboos.
Goal	Remedy the protein deficiency and cure the kwashiorkor.
Gather Information	Diet, culture, symptoms, treatment, area resources, principles of culture change.
Possible Solutions	Increase fruits and vegetables in diet Change "ancestor" attitudes Change food taboos Use protein concentrates (powdered eggs, milk) Work around taboos Develop new high protein foods (chicken, rabbits, peanuts) Build a pond and raise fish
Constraints	Negative ramifications of culture change Opinions, wishes, taboos of people Feasibility Time Communication Ethics
Choose	Use a table to evaluate the possible solutions using criteria based on the constraints. Then rank the solutions and choose the best one: protein concentrates.
Analysis	Identify key factors which must be considered in a "pilot project" to test the chosen solution: who will taste the food, when, where, etc.
Synthesis	Design a pilot project.
Evaluation	Evaluate given pilot project data and determine the effectiveness of the solution.
Recommendations	Prepare recommendations for further work.

Figure 3.3. Anthropology Project Outline. Reprinted with Permission of Wales, C. E. and Nardi, A. H.

Introduction

A medical team has determined that over half the settlers in the new village of Rwamkoma, Tanzania, suffer from kwashiorkor, a severe protein deficiency. This disease is caused by a lack of high protein food in the diet. They also found that the villagers were not willing to change their dietary habits because of strong food taboos and ancestral beliefs. To solve these problems an anthropologist, Dr. Jan Ellickson, has been called in. Your group of exchange students was asked to work with Dr. Ellickson to learn about the approach used by a social scientist.

Instruction A-State the Goal of the Project Work

The team of students met with Dr. Ellickson to discuss the problem. After a short explanation of the situation, she asked them to state the goal of their work.

Feedback A

The group discussed four ideas: 1) make the people healthy; 2) cure the protein deficiency; 3) change existing food habits; 4) get them to take protein pills. They finally agreed that the first idea was too broad and that ideas three and four were possible solutions not goals. This left the second statement, cure the protein deficiency, which they selected as their goal.

Instruction B-Identify Information Needs

As the discussion continued, the students realized that they knew very little about the specifics of the problem. Dr. Ellickson suggested that they list the information they would like to have.

Feedback B

The group decided to pursue information on the following topics before proceeding further.

1. The present diet of people
2. The culture of the people
3. The symptoms and treatment of the disease
4. The natural resources available in the area

Dr. Ellickson congratulated the group for developing a good list and then suggested one additional item, information on the principles of "culture change."

Instruction C-Generate Possible Solutions

Dr. Ellickson gave the group several papers and reports to read. These would provide them with much of the information they needed; material on anthropology, communications, ethics, economics, agriculture, and the food taboos of people.

Dr. Ellickson asked members of the group to complete their reading, and then generate a list of potential solutions to this health problem.

Figure 3.4. Kwashiorkor in Rwamkoma. Reprinted with Permission of D'Amour, G., and Wales, C. E.

Some Guidelines for Developing the Project

Often the most difficult task is creating the problem situation. All we can say is that it takes some practice, but eventually you'll find that the job becomes easier as you begin to see possible Guided Design projects all around you. However, a few suggestions will help to get you started:

- Make the problem situations as realistic as possible. Try to use characters who seem real and who are faced with realistic problems. Although it may seem clever at the time, we've found that using "funny" names for people or for companies only detracts from the project by indicating to students that the problem and people are not real and need not be taken seriously.
- The problem situation should be relevant to the students. It should be a problem to which they can relate, one that they might face now, upon graduation, or soon after. In fact, you might consider developing Guided Design projects that relate to the course, such as designing a peer evaluation system or forming groups, if such projects are appropriate.
- Try to use situations with which you are familiar, either from your own experiences or ones you have read about. This will help you to make them appear more realistic to the students. Also don't be afraid to call on colleagues for their ideas and contributions.
- The problem should be one that allows for several possible solutions. It is preferable if each possible solution has its own pros and cons so that no one solution is clearly best.

After a particular project is used once with a class, you will probably see many ways it can be improved. You might also try testing the projects on colleagues before they are used in class. Figure 3.5 provides more detailed advice on creating the project.

1. Do outline the project first.
   Don't just start writing.
2. Do design a project which requires the learners to use new concepts you want them to study and learn.
   Don't write a project which is solely a vehicle to transmit new concepts. Instruction-Feedback sets should not be mini-lectures.
3. Do write a project which uses most, if not all, of the decision-making steps.
   Don't require learners to perform the "gather information" step over and over again.
4. Do have a storyline that flows through the project.
   Don't use a storyline that is unrealistic or irrelevant to the interests of the learners. Don't ask them to play a role which is clearly beyond their ability. Let them be themselves if you can.
5. Do label each instruction with an appropriate decision-making step.
   Don't think you have to use the decision-making steps in the order we listed them or force your project to fit unnaturally. These steps can be used in several ways.
6. Do ask learners to make meaningful, non-trivial, decisions.
   Don't tell the learners something that they can think through on their own.
7. Do write Instruction-Feedback sets which describe what "she" (the professional) did or "he" (the apprentice) did.
   Don't prepare a Feedback which is likely to threaten the learners (e.g., "You should have arrived at the following conclusions.")
8. Do write Instructions which the learners can discuss in a reasonable amount of time (usually 5 to 20 minutes).
   Don't write Instructions so complex that the learners have little chance of answering or which take an extraordinary amount of reading time.
9. Do make sure the Feedback responds directly to what was asked in the instruction.
   Don't include extra information or a new instruction in a Feedback. Related ideas may be added in the next instruction or in an information section.

Figure 3.5. Guidelines for writing Guided Design projects. Reprinted with permission of Wales, C. E. and Nardi, A.

WRITING THE PROJECT

The Instructions

In general, each decision-making step can correspond to one instruction—feedback step in the Guided Design project. Thus, you will need to develop an instruction that directs your students to perform each of the decision-making steps as they work through the project, and an appropriate feedback for each instruction.

Remember that one purpose of these projects is to teach your students to become experienced decision-makers. Right now they are probably very inexperienced or, worse, have too much experience in making decisions the wrong way. Thus, your early projects should provide a lot of guidance, working through each of the steps very slowly. In addition, you should be aware of the two most common errors in decision-making and be careful to guide your students away from them.

Common Errors

Probably the most common error made by inexperienced decision-makers is to develop possible solutions before they have identified the problem and stated their goal. We find over and over again that students are always trying to find ways to jump right to the "possible solutions" step. The best way to avoid this is by giving very concise instructions at the project's outset that the students are not to consider possible solutions until told to do so.

The second error, which is less likely among students, but which we see our colleagues falling into all the time, is "serial decision-making." This is a variation of the above, but only one possible solution is considered at a time. After one is rejected, another is tossed out and considered until finally a solution is found that everyone accepts. Of course, this may be a solution to the wrong problem. As with the first error, the best way to avoid serial decision-making is to ensure that students are forced to define the problem and state their goal before even considering possible solutions.

For the first few projects that your class tackles, the same theme should be followed on all instructions: give very concise instructions about what you want the students to do, and guide them away from the two common decision-making errors. As your class gains more experience, we have found that these instructions can be reduced or even eliminated. However, to keep everyone on course, you might want to consider having them follow an outline of the decision-making steps on every project.

Feedback

In general, there should be one feedback for each instruction. Again, with the first few projects this feedback should be very exact. For instance, you might want to go into some detail about why students must define the problem as the first step, giving examples to show how it's possible to solve the wrong problem otherwise. Later, the explanations given in each feedback can be reduced.

Keep in mind that the purpose of feedback is merely a guideline. Neither you nor the student should consider it as a "right answer." In fact, to get this idea across, we usually do not include every idea, nor even the best idea, in the feedback. Instead, we present possible responses the students might have developed for the instruction only to the point where they get the idea of what they should have done, not any specific answer they should have developed. We've found that it's very encouraging to the students if they think their response to the instruction is even better than the feedback.

Another device we use to avoid this "right answer" mindset is to word the feedback in terms of what the protagonist of the project did. We let this person be a professional who has good ideas, but maybe not the best. Students feel much better about disagreeing with "Bill" or "Mary" than they do about disagreeing with what their teacher (you) has said. Remember again that the goal of these projects is to develop independent decision-makers. So long as the students are following the decision-making steps and using the content material, don't be afraid to let them follow their own path. In fact, we have found that student groups often develop problem solutions that we never thought of and that, frankly, are better than ours.

Combining Steps

You may want to combine steps under some circumstances and break steps into sub-steps under others. For instance, we have found that with large classes, a great deal of time will be spent in distributing instructions and feedback. To reduce this wasted time, we have been able to combine several steps together into "stages" as follows.

Stage 1. Identify the problem, state the goal, and gather information.

Stage 2. Component analysis and generate possible solutions.

Stage 3. List constraints and assumptions, then choose.

Stage 4. Analysis, synthesis, and evaluation.

Stage 5. Recommendations and report.

You should be sure to notice that we have not dropped any steps. Instead, we have combined some. Remember that each step of the decision-making process is important and none should be left out.

By combining steps into stages, the sheer amount of paperwork in a large class section can be reduced. There may even be instances in small classes when it is desirable to combine steps.

On the other hand, students often have trouble differentiating between problem causes and symptoms or between constraints and facts. To help them discern the differences, you may want to break some steps into sub-steps, e.g., we have found this especially useful in the case of constraints and facts. Students can be asked to list all the facts first. Then the next step can ask them to identify which facts restrict their possible solutions. These restrictions will be the constraints.

PART II

IMPLEMENTING GUIDED DESIGN

Chapter 4: Transition
- Comprehensive Example
- Forming Groups
- Group Exercises
- Steps of Decision-Making
- Group Dynamics
  - Group Process
- Introductory Project
- Reinforcement
- Transition Schedule

Chapter 5: Course Management
- Personnel
- Scheduling
- Physical Arrangements
- Managing the Groups
- Lectures
- Grading
- Record Keeping

Chapter 6: Keeping the Course Alive
- Accepting the Innovation
- People and Change
- Common Issues in Implementation

Overview

In Part I we talked about planning for the course. One of the most important characteristics of the planning stage is the fact that you are probably the only one involved in the course, i.e., unless you have a team working to develop the course materials, you will only have to manage your own time. When it comes to implementing the course you will not only have to manage your own time, but the logistics of people, places, and things associated with the course. This, indeed, is no small task. Chapters Four and Five are an attempt to help you translate what looks good in theory (your course materials) to what works well in practice (the class itself).

In Chapter Four, *Transition,* we will discuss the need and value of introducing learners to the Guided Design process. It has been our experience that many students who encounter a Guided Design course (or any new experiential learning technique) for the first time have difficulty adjusting to these new expectations. To help alleviate the problems of adjustment we systematically introduce students to the components of a Guided Design course and allow them to practice many of the skills they will need before they begin the course content.

In Chapter Five, *Course Management,* we will discuss the administration of the course. A Guided Design course will require more record keeping and supervision than a traditional lecture/discussion course. We have identified seven areas that you will need to attend to as the course progresses. If you will be teaching a course with a large enrollment these management issues will be especially important to keep the system from reaching entropy.

CHAPTER 4

TRANSITION

Introduction
Comprehensive Example
Forming Groups
Group Exercises
Steps of Decision-Making
Group Dynamics
  Group Process
Introductory Project
Reinforcement
Transition Schedule

Introduction

Students have spent most of their academic lives sitting in a classroom memorizing facts and formulas. They are usually rewarded for this behavior with high grades. In so doing, they have developed an expectation of what is to happen in the classroom. If you abruptly change these expectations, they will usually balk; if you fail to show them how the expectations have been changed, they will become confused and angry as they try to use old strategies to cope with a new environment.

We have found that it is important, especially with large groups, that a series of transition exercises be presented during the first days of the course. These exercises provide the student with:

- A comprehensive and real world example of how a professional in the discipline solves a complex, open-ended problem.
- Opportunities to meet and work with other students before having to select permanent group members.
- An introduction to the theory of the Guided Design teaching technique.
- An introduction to small group dynamics and how to work in a group.
- An introductory Guided Design project in which the students apply, at a basic level, all of the skills needed in solving realistic problems.

COMPREHENSIVE EXAMPLE

Studies of the learning process have shown quite conclusively that meaningful material, material that possesses a pattern, is familiar, or satisfies a need, will be more quickly learned and remembered longer than non-meaningful material. (Which pattern is easier to remember: 1010101 or 1oei63viaz? What was the phone number you had before this one?)

Because learning is facilitated by relevance, we begin the course with a comprehensive and real world example of how a professional in the discipline solves a problem using a structured decision-making technique. This example provides the learner with a reason for attending to the content and the process of the course. (In addition, relevance should be reinforced throughout all course projects not just at the beginning.)

Our comprehensive example takes approximately 40 minutes to present and unfolds in four parts:

- Define very clearly what the subject matter of the course is.
- Provide real world problems that illustrate why the subject matter is important.
- Indicate how a real problem can be solved using the structured decision-making approach taught by the Guided Design process.
- Discuss why it is important to learn such a decision-making approach and how the course will emphasize not only content acquisition but decision-making skills.

This sequence will work in most any discipline that requires decision-making. *It is most important that you develop an example that is relevant and preferably novel in the students' lives.* It is also important that the description of the example use concrete referents rather than abstract ones, e.g., if you describe a manufacturing plant as encompassing 600,000 square feet you won't get the same reaction as describing it as larger than 13 football fields.

Here is an outline for the comprehensive example in a course in Production-Operations Management as it is presented to the students.

- Define very clearly what the subject matter of the course is:

Production-Operations Management is the process of managing the people and equipment that convert raw materials and resources into goods or services. In this course you will learn the techniques that are used in successful organizations to plan their production, schedule production activities, control those activities, and also to effectively manage the company's production resources.

- Provide real world problems that illustrate why the subject matter is important:

  In a large manufacturing plant such as Black and Decker, there are numerous problems to be solved and decisions to be made. Black and Decker, which manufactures power tools, must determine how many drills, saws, hedge trimmers, etc., to produce each week; schedule the people and machines to produce them; and ensure that the necessary parts and raw materials are available. For instance, just one of their plants covers an area equal to more than 22 football fields and produces over $200 million worth of electrical tools each year. More than 120 basic tools are made in over 900 possible configurations. Black & Decker's customers expect orders to be filled within 1 week. Yet with all this complexity, B & D is one of the most successful companies in the world. In an age where Japanese competition is running us ragged, B & D is able to compete effectively. If you don't believe this, go into K-Mart and see how many Japanese power tools there are, then compare this to the number of Black and Decker power tools. In fact, B & D sells its product in Japan! To solve their production problems, B & D managers employ exactly the same techniques for problem-solving and decision-making that will be learned in this course.

- Indicate how real problems can be solved using structured decision-making:

  For example, consider the use of operating rooms in a hospital. If you are a hospital administrator and physicians have been complaining they didn't have enough operating rooms, yet you have often seen the operating rooms sitting idle, you might begin thinking that the problem could be identified as poor scheduling or inefficient use of resources. An experienced hospital administrator might state the goal as follows: To use operating room facilities to their utmost while providing satisfactory service to physicians and patients.

The next step is to list the facts and then determine which facts will limit your possible solutions. You may need to make assumptions to fill in missing facts. For instance, the hospital administrator might collect operating room usage data for the past few years. A constraint could be limited budget for expansion. Assumptions might have to be made about future growth in demand.

Possible solutions are developed next. In this case, the administrator might list the following:

a. Add more operating rooms.

b. Use alternative resources, such as outpatient surgery for minor problems.

c. Encourage physicians to schedule elective surgeries during low demand periods.

The last step is to select a solution, develop it, and evaluate the results. In this case, the administrator would choose a solution, work out the details, then determine whether it produced the desired results. If not, more work or a new solution might be required.

- Discuss why it is important to learn such a decision-making approach and how the course will emphasize not only content acquisition, but decision-making skills:

When you arrive on the job for the first time, it is exceedingly unlikely that the decisions you have to make will be listed in your old textbooks with the answers in the back. You will be encountering situations where you must create a solution to a previously unencountered problem. Your employer expects you to make the decision, not your boss and not your competitor. If you can't decide then someone else will and you will soon be looking for a new job.

Problem solving is generally considered one of the most complex forms of human behavior. Learning to make complex decisions, as with learning any new skill, takes time and practice. However, we think you will find that the Guided Design approach will teach you a way to approach new problems in a systematic manner that will increase your chances of success in new tasks.

FORMING GROUPS

When a student walks into class on the first day, especially if the class is large, the initial reaction is to drop into the seat, take out a notebook, and wait to be lectured to. As an object, the student is at rest and will probably remain at rest for the duration of the course unless a new force is applied. If you immediately ask students to form groups for the course, you will find that they tend to gravitate either to the few people they already know in the course or to those in adjacent seats. We have found that this behavior rarely produces a strong group.

Instead, the environment should be structured so that students meet other class members and have a chance to work with them. Only after they have met and worked with a number of other people should they be asked to form a group for the length of the course. After they have worked with a number of other students, they will be able to make a more considered choice in selecting group members.

Because most students come to you as an "object at rest", it will be necessary for you to structure the environment so that they become "objects in motion" that meet and interact with others. One way of creating this environment is to assign the students randomly to a number of temporary groups during the transition period. To make this work we have used the following procedures:

- Take the total number of students in the class and divide this number by the size of group you want, e.g., 80 students/4 students = 20 groups of four.
- Use 3x5 cards, (four cards to create groups of four, five to create groups of five, etc.) with the same number on them. Do this for enough numbers to cover everyone in the class, e.g., a class of 80 broken into groups of 4 will have four cards with the number "1", four with "2", etc., totalling 20 groups.
- Shuffle the cards.
- As students enter the room, give each a card.
- Have the students with the same number join together for the transition exercise. In large classes you may need to help the group members find each other by designating certain seats or a row of seats as group 1, another as group 2, etc. (This seating plan can be put on the overhead or group numbers taped on the seats before class.)

- Have the group members introduce themselves, and exchange names and phone numbers for future contact.

  (Note: Distribute the cards, have students join together and introduce themselves at the *start* of the class period. You will lose a fair amount of class time if you allow the students to get settled, talk with them, and then distribute the cards.)

Finally, we have found that at least four such temporary groups should be formed during the transition so that students know at least 12 other students before choosing members for the permanent group.

GROUP EXERCISES

The Guided Design process works best when it happens in a group. In Guided Design courses the students usually need to learn the decision-making steps as well as how to work in groups. Rather than immerse students in both realms at once, we prefer to introduce them first to group activities, then to Guided Design decision-making steps, and finally to the combination of both activities.

So that students have practice working in groups, and can see the positive aspects of group work, we use a variety of exercises. We use at least four exercises during the transition period before we even allow them to work through a Guided Design exercise. First, you might use this exercise:

> To the class as a whole, tell each student they have one minute to list 30 different types of birds. At the end of the minute, ask how many different birds students listed. Next, using the class as a group, have the students call out the name of 30 different birds and write them down on an overhead or board. Most will see that this task is considerably easier for a group to complete than for an individual.

Other such group exercises for the transition period are listed in Appendix A: Transition materials.

STEPS OF DECISION-MAKING

One purpose of Guided Design is to teach students to solve complex, open-ended problems. As part of this, they should be learning to follow a specific sequence of decision-making steps as they work through the Guided Design projects. However, most students become too involved in the details of working through the projects to learn adequately the steps they are following in the decision-making process. Before they start on any projects, students should learn these steps and understand their significance.

One way of doing this is through a self-instruction unit on the decision-making steps. We have included such a unit in Appendix A. You should note that this unit describes a decision-making process that combines steps (see WRITING THE PROJECT). We used these combined steps throughout the course. Don't begin with an introduction to decision-making that is detailed, e.g., 13 steps, and then teach with a combined, e.g., 5 steps approach. This inconsistency may create confusion among the students. Alternatively, a handout can be given describing the steps, providing examples and a rationale for each step.

During the first week of class, we even give a quiz on this material. However, like all our quizzes, this is short and covers only the basic ideas. Our main purpose is to at least get the students acquainted with the steps of decision-making before their attention is distracted by trying to apply decision-making strategies to course content material in the Guided Design projects. After this, following the same decision-making steps on a Guided Design project will help reinforce the students' learning of those steps.

GROUP DYNAMICS

Working in groups may be a new experience for most students. Even if they have worked in groups previously, those experiences may have been unsatisfactory ones from which the students learned poor group work habits or developed a bad attitude toward group work. Therefore, it is important to show students that group work has several positive sides (see GROUP EXERCISES) and to give them some training in positive group work habits.

Most students are woefully naive about working in groups. Left to themselves, they will try to hold group discussions sitting in a straight row, meet at somebody's apartment with the stereo and TV blasting while trying to perform project work, or even assume that everyone can work on a different part of the project with no interaction among group members. We found it beneficial to begin with and enforce these rules in group work:

- Hold discussions sitting in a circle. (Sometimes we have had to all but force groups into a circle from their normal straight line arrangement!)
- Meet in a location free of distractions, such as a meeting room in the library.
- Give everyone a specific job to do and meet together often to report on each person's progress.
- Confront group problems (lazy members, members who will not cooperate) early on and develop a concrete solution to these problems.

We have found that it is best to tell students that they should expect their group to have some problems, but that if they confront these problems they can be solved. Bad group experiences typically stem from a problem that students ignore and must suffer with through an entire semester.

Some ideas you may want to try are the following:

- Assign a specific job to each group member. Change these job assignments from one project to the next. For instance, one person could be made the leader. This person is responsible for managing the group, coordinating activities, arranging meeting times, and organizing the final report. There may be two persons called planners. Their job is to perform any necessary calculations or analyses of problem factors. Finally, one person can be a researcher. This person can be responsible for collecting outside information or doing research at the library.

- Allow students to evaluate each other's work by using peer evaluations. (See GRADING, Chapter 5) What is important for the transition period is that you introduce whatever, if any, peer evaluation process you will use throughout the course. In GRADING we present one such scheme we have found that works reasonably well and is easily understood by the students. You may wish to try other schemes.

Group Process

Research indicates that, in general, any group will pass through four distinct phases in its development. Understanding these phases and expecting them will help both you and the students to manage the group experience more effectively. We recommend that these phases be presented and discussed during the "group dynamics" presentation in the transition classes. The four phases are described below.

Forming. During this phase the group members are discovering acceptable group behavior, group boundaries, and group rules. They are concerned with finding out what the group has to offer them and what they will be expected to contribute in return. By setting concrete standards and policies for performance and behavior in groups, you can develop positive group philosophies during this important stage. The rules listed above are a good place to start.

Storming. As the group's individuals get to know each other, personalities and preferences may emerge that lead to infighting and cliques. Individual members may attempt to exert control over other members to achieve a desired position in the group's hierarchy. Changing the roles on each project may help to reduce this conflict. However, it should not be stifled altogether since the storming phase may produce a stronger group in the end. On the other hand, if group problems become too severe, you may need to help deal with them. (See MANAGING THE GROUPS, Chapter 5)

Initial Integration. The group will begin to form itself into a working unit, adapting to individual differences of its members. At this phase, the members may feel closeness, although it is probably superficial. The general attitude will be "don't rock the boat." Unfortunately, this attitude may lead the group to cover up some serious problems. In GRADING we discuss some ways that the peer evaluations can be used to get the boat rocking again.

Total Integration. At this point, the group will be a mature, integrated working unit. It will be able to handle creative disagreement well and members will be motivated by the group goals.

In a regular semester, it may not be possible for all groups to reach the fourth phase. In fact, many never get past the first. Often the reason for lack of progress is an expectation that everything should run smoothly in the group. This may lead students to hold back criticisms or emotions, stifling the group. You can encourage group members to bring these out through peer evaluations and interactions with the group or individual group members.

INTRODUCTORY PROJECT

Because Guided Design as a teaching technique, and the Guided Design projects themselves, will be a new and unique experience for the students, students should be given a chance to work through a practice project before starting on any Guided Design projects for credit.

As part of the transition process, give the students in your class a chance to work through a practice Guided Design project and they will be much less apprehensive about their first project for credit. It is also important that this practice project be as similar as possible to the actual projects to be used later. *We have found that this practice project can build very strong expectations about the projects to come.* If large differences between the practice project and the credit projects result in these expectations not being met, then the practice project will have really worked against a smooth transition.

For example, the practice project should have as many steps and the same type of feedback as the projects that follow it. It should also be drawn from the same discipline. If the course is one in nursing, then the practice project should be a nursing problem. If the discipline is philosophy, then the project should deal with a problem in philosophy. However, the practice project should not require skills the students do not yet have. Likewise, the more relevant this practice project is to the students lives, the better.

- The practice project in an accounting course might deal with a personal income tax problem.
- A nursing course could have a practice project that considers whether to specialize in a particular field of medicine or how to care for an ailing relative.
- The philosophy course could present a practice problem concerning a decision about whether to report a fellow student who cheated on a test.

REINFORCEMENT

In the best of all worlds, people would work and learn because of their intrinsic interest in learning and because work can contribute to our individual self actualization. This assumption, labeled by MacGregor as Theory Y, is in contrast to Theory X. Theory X follows from the assumption that work is a negative event in one's life and that powerful rewards and punishments need to be implemented to keep people performing.

We have found that students described by each theory—Theory X and Theory Y—are assembled in the same class. (In fact, it seems that in a large lecture setting the majority of the students are described by Theory X; Theory Y better describes students in smaller classes.) Because the Guided Design approach requires that all students be actively involved in the instructional process, we feel it is important to assure some level of consistency in learning. We have accomplished this consistency by implementing two types of reinforcement activities during the transition: group homework assignments and quizzes. (For Theory X students these represent the necessary external impetus for learning; for Theory Y students it is a reward for learning that would have taken place with or without external reinforcement—you can't lose!) Quizzes and homework are also useful in that they provide a check for the learner to determine whether they do indeed know the material. These activities are also useful for the instructor in that response patterns can be reviewed to determine whether or not students are having difficulties with a particular concept in the transition.

- Homework from the groups consists of the practice problems that were assigned the group or the results of the first Guided Design exercise. *Be sure to collect the homework at the beginning of the class for which it is due.* If you wait until after you have discussed the homework with the class, you will tempt the Theory Xs to report the results without doing the exercise.
- Quizzes should be given to the entire class on the *Steps of Decision-Making and Group Dynamics.* These should also be given at the start of the class for which they are assigned. Quizzes should be graded on an individual basis because this material is not appropriate for group work.

TRANSITION SCHEDULE

To give you a guideline to follow for the transition phase, we have included the following schedule for 6 one hour classes. This schedule has worked well for us in practice, but may be revised to meet your own needs.

Session	Activity
1	Assign first temporary groups (*See Forming Groups)* *Comprehensive Example* *Group Exercises* Give group exercise #1
2	Assign second temporary groups Collect group exercise #1 solutions Introduce basic concepts of Guided Design Give group exercise #2
3	Assign third temporary groups Collect group exercise#2 solutions Explanation of decision-making Give Decision-Making Self-instruction unit for homework Give group exercise #3
4	Assign fourth temporary groups Collect group exercise #3 solutions Quiz on Decision-Making Self-Instruction Unit *Group Dynamics* and discussion Give overview of *Introductory Project*
5	Give quiz on *Group Dynamics* Do *Introductory Project*
6	Students pick permanent groups Introduce and assign first course project

CHAPTER 5

COURSE MANAGEMENT

- **Introduction**
- **Personnel**
  - **Span of Control**
  - **Expanding the span of control**
  - **Recruiting extra help**
- **Scheduling**
  - **Scheduling of quizzes, projects, and exams**
- **Physical Arrangements**
  - **Physical environment**
  - **Scheduling of facilities**
- **Managing the Groups**
  - **Forming groups**
  - **Group meetings**
  - **Group member roles**
  - **Dealing with group problems**
  - **Group divorce**
- **Lectures**
  - **Motivational lectures**
  - **Informational lectures**
- **Grading**
  - **Quizzes**
  - **Tests**
  - **Group Projects**
  - **Peer Evaluations**
- **Record Keeping**
  - **Peer Evaluation Backup**
  - **Computer Programs**

Introduction

In order to make your Guided Design class function properly you'll have to do some careful managing of components. You will need to plan, organize, and control the educational process so that your students receive as much benefit from the Guided Design process as possible.

One of the first problems with which you'll have to deal is to develop a schedule for your class. Unlike a lecture class where there is usually considerable flexibility, we have found that a Guided Design class must be carefully planned out ahead of time. This chapter begins by presenting some ideas and methods that we have developed for scheduling all the activities in a course so that things will go smoothly.

You will also need to be concerned with personnel to assist you (if needed), and physical arrangements for the class. Again, we present some ideas based on our experiences.

The final aspects of course management are grading and record-keeping. We try to use the grading process to provide feedback to the learner as well as increase the motivation to learn. Record-keeping can be complicated if you have a large class, so we have included a computer program in Appendix C to help with this process. Otherwise, we discuss some general concerns in the record-keeping process.

PERSONNEL

Span of Control

The use of Guided Design usually means considerable time must be spent providing advice to the groups, answering questions, and giving feedback. For a large number of groups, it just may not be possible for the instructor to handle all these activities effectively. While the specific number of groups that one person can deal with—the span of control—may vary depending on the course content and level of students, we have found that, in general, five groups is an upper limit.

Expanding the Span of Control

Under certain conditions it may be possible to increase above five the number of groups that can be handled by one person. For example, decreasing the number of instructions and feedback as mentioned elsewhere *(Group Projects)* can reduce the required level of instructor involvement. Likewise, handouts can be used to answer specific questions that may be common to all the groups. We have also found that if all groups are having difficulty with a specific concept or technique we will give a "mini-lecture" on that topic to the entire class rather than explaining the topic over and over again to each group. It is also possible to let the groups run without feedback for an entire class session, then let them pick up the appropriate feedbacks on their way out so the feedbacks can be studied before the next class.

Recruiting Extra Help

You may find that dealing with five or more groups leaves you running around constantly, unable to spend sufficient time with each group. It may be time to get some assistants. These assistants can be recruited from graduate assistants, colleagues, or from students who have already taken the course.

- Team teaching in a Guided Design course is an excellent way to reduce the group load and also allows you to introduce colleagues to this technique.
- One thing that we have found works very well is to recruit student assistants from the previous semester's class. We use this as an honor, only taking students in the top 10% of the class, and rewarding them with academic course credit for their

work. These helpers are usually very conscientious and highly motivated. They also know how Guided Design should work.

- Another possible source of help can come from graduate assistants if they are available. This alternative can be less expensive than using faculty and usually overcomes the problems of giving course credit to helpers. However, most graduate assistants are as unskilled in decision-making as the students they will be working with. If you're not careful, they may end up short-circuiting your work by encouraging students to skip steps in the decision-making process. *We recommend that you give your graduate assistant help a thorough indoctrination into Guided Design and the decision-making process before they start working with your students.*

SCHEDULING

We have already discussed the idea that a transition period is needed for Guided Design and presented a possible schedule for that transition. However, we have also found it important to plan and schedule activities during the rest of the semester.

Scheduling of Quizzes, Projects, and Exams

In *Grading*, we will discuss in more detail the way that quizzes, projects, and exams may be used. However, all these activities should be scheduled so that their contribution to the learning process is maximized.

QUIZZES

We have found that a worthwhile approach is to schedule a short quiz before the beginning of each project. The purpose of this quiz is to determine whether students have adequately prepared the material that they must apply to the project. Its purpose is not to test specific details, since much of the learning will occur during the Guided Design project. However, students should have a basic understanding of the material that they will be expected to use. We usually do just a short, five question, five minute quiz before the project starts to help motivate the students to prepare for the project.

PROJECT SCHEDULING

We have already discussed how projects should fit into the blueprint design of the course *(Hierarchical Analysis)*. In addition, each project should be scheduled for an appropriate amount of course time. One possible approach is to plan to complete a certain number of instruction/feedback steps at each class meeting. In general, the earlier steps of decision-making will proceed more quickly than the later ones. In case you do not complete the planned number of steps in a given class period, you can either make these up later or else give out the last ones at the end of class, asking students to read these on their own. This latter course is not part of the Guided Design theory, but sometimes becomes a practical necessity.

You may also wish to give your students a schedule of the steps you expect them to complete during each class. This can help them plan their work. Some teachers even ask the students to submit a timetable of their expected work for large projects. In any case, it will help your students and you if you can keep everyone from putting off their work until the end.

EXAM SCHEDULING

We have found that the ideal time for us to have an exam is right after a Guided Design project has been completed. If you are coordinating these projects with the course structure, then students will have just learned a complete set of material. In addition, having just used that material on a project, it will be fresh in their minds.

COURSE SCHEDULE

One device we use to help keep everything running smoothly is a course schedule. This schedule indicates exactly when quizzes, exams, and projects will take place. In addition, you can even indicate specific steps of each Guided Design project that should be completed during a class session. A sample of such a schedule is shown in Figure 5.1.

PHYSICAL ARRANGEMENTS

It is important that the physical arrangements for a Guided Design class be appropriate to the methodology. For example, if you will have your students working in groups, it is important that they be able to arrange their seats so that group members can face each other and that there is adequate space between groups.

Physical Environment

Some instructors who use Guided Design have been able to obtain a special room with chairs placed around tables so that students may see one another. However, a classroom with movable chairs also works well. A lecture hall with fixed seats does not.

We have found that for large classes, we schedule two rooms: one large lecture room for exams and course lectures and a small room with movable chairs for group work.

Scheduling of Facilities

If your class exceeds 50 students or so you may find that it's best to meet with only part of the class on each day of the week. In our large classes of 180, we divide the class into thirds, meeting with only one third each day of the week for group work. During the other days these groups are expected to continue their work, doing research, performing calculations, and studying the content material. For exams, all students meet on the same day in a large lecture hall. This requires that specific exam dates be planned at the beginning of the semester and all students be given a schedule of these dates.

	Day of the Week		
Week	Monday	Wednesday	Friday
1	Assign first temporary groups COMPREHENSIVE EXAMPLE GROUP EXERCISES Give group exercise #1	Assign second temporary groups Collect group exercise #1 solutions Intro. to GUIDED DESIGN Give group exercise #2	Assign third temporary groups Collect group exercise #2 Explanation of Decision-Making Give Decision-Making Self-Instruction unit Give group exercise #3
2	Assign fourth temporary groups Collect group exercise #3 solutions Quiz on Decision-Making Self-Instruction unit GROUP DYNAMICS discussion	Give quiz on GROUP DYNAMICS Do INTRODUCTORY PROJECT	Students pick permanent groups Introduce and assign first unit
3	Motivating lecture on Forecasting	Forecasting quiz Begin Project #1: Forecasting	Continue work on Project #1
4	Continue work on Project #1	Continue work on Project #1	Continue work on Project #1
5	Continue work on Project #1	Reports due on Project #1	Exam on Forecasting
6	Motivating lecture on Aggregate Planning and MRP	Quiz on Aggregate Planning and MRP Begin Project #2: Aggregate Planning and MRP	Continue Project #2
7	Continue Project #2	Continue Project #2	Continue Project #2
8	Continue Project #2	Continue Project #2	Continue Project #2
9	Report due for Project #2	Exam on Aaggregate Planning and MRP	Motivating lecture on Inventory Control
10	Quiz on inventory control Begin Project #3: Inventory Control	Continue Project #3	Continue Project #3
11	Continue Project #3	Continue Project #3	Continue Project #3
12	Continue Project #3	Continue Project #3	Final report due for Project #3
13	Exam on Inventory Control	Motivating lecture for Capacity Planning	Quiz on Capacity Planning. Begin Project #4: comprehensive project
14	Continue Project #4	Continue Project #4	Continue Project #4
15	Continue Project #4	Continue Project #4	Continue Project #4
16	Finals week: Project #4 reports due and final exam on all course material.		

Figure 5.1. Daily schedule for Production-Operations Management Course.

MANAGING THE GROUPS

The majority of students have very little group experience in their education. Most of their learning has involved individual efforts. However, Guided Design utilizes group activities because much work after graduation is performed in groups and because groups can usually reach better decisions than an individual. Unfortunately, the problems that arise in groups can hinder learning and lead to the students' rejection of Guided Design. Techniques must be utilized to avoid these problems or to turn group conflicts into positive educational experiences.

Because most students are inexperienced at group work, we have found that they need some specific guidelines and rules to work by. These guidelines and rules are designed to avoid unnecessary conflicts while bringing important problems out into the open; they will also help students get the most from their work in groups.

Forming Groups

GROUP SIZE

We have already discussed the idea of temporary groups and how they can be assigned. We suggested breaking the class into groups of four. The reason we chose four is that our experience has shown this to be the optimal number for an effective group. Larger groups tend to be less cohesive, encourage the formation of cliques, and enable some group members to avoid their fair share of work since enough others remain to get the job done. Smaller groups do not seem to have the necessary critical mass for a free and open exchange of ideas. In addition, smaller groups may become overburdened with too much work on difficult projects. For us, groups of four seem to work best. However, you may find that you like larger or smaller groups better. One colleague has been successful with groups of eight.

TEMPORARY GROUPS

As was mentioned in the chapter on Transition, students should have time to work in temporary groups before selecting permanent groups. If they are constantly reminded during that time that they will be expected to pick a permanent group on a given date, then students are more likely to devote effort to considering with whom they would like to work. The specific day for selection of permanent groups should be announced well ahead of time.

PERMANENT GROUPS

Although it may be difficult, the best arrangement on the permanent group selection day is to have all students enter a large room with no chairs so that they must remain standing. Otherwise, they can easily negate all the temporary group experience by choosing whomever sits next to them. With everyone standing, they can circulate freely to search out others to form their groups. It is important to encourage students to form their groups rationally rather than just picking whoever is convenient.

Whenever groups are formed, there will always be some people left who are not in a group. The easiest thing is to just combine these people, forming a group. We discourage this. Usually such individuals are not very aggressive, they were waiting for someone to put them in a group rather than selecting their own. Typically, a group formed from these individuals will tend to have weak leadership and be rather incohesive. Instead, we recommend that efforts be made to recruit each of these people into a different group. Groups of three can often be filled up to four in this way. Even if some groups have five members, this is usually preferable to having a weak group.

Once groups are formed, various team-building activities can be used to develop cohesiveness. An easy one is to let each team pick a team number, then later a team name.

Group Meetings

Left without guidance, students will often hold their group meetings under the worst possible conditions, leading to poor group results and frustration among the members. To avoid this, we provide the following guidelines:

- Hold group meetings in a quiet place free from distractions, e.g., no radio, stereo, or TV. Meeting rooms in the library are good for this.
- Sit in a circle so that everyone can see each other and talk freely without having to lean past others. (This makes classrooms with fixed seats undesirable.)
- Encourage everyone to state his or her opinion and to contribute ideas. Don't just criticize, but consider the pros and cons of each suggestion.
- Feel free to "brainstorm" for a while, but if you feel you're getting nowhere, decide what you want to accomplish before adjourning and try to get it done.

- Set a specific time and place for the next meeting and be sure that everyone is there on time.

You probably covered these points during the transition period, but it helps to emphasize these rules as they become more relevant and meaningful for the graded group projects.

Group Member Roles

One way to ensure the participation of each group member is to assign specific roles for each member to perform. This way, if one person does not perform a job, it is more likely that their inaction will be noticed by the other group members and action taken to correct it. In a group of four, we have found that the following roles seem to work effectively: group leader, planner, and researcher.

- The group leader is responsible for coordinating all activities of the group, scheduling meetings, and informing group members of the meetings. He or she is also responsible for writing the body of the report and collecting necessary substantiating data from the other members.
- The planners are those people who actually perform calculations that are required as part of the project. Their activities are directed by the group leader, to whom they submit the results.
- The researcher is responsible for obtaining data from the library or other sources of outside information. The exact nature of the data will be dictated by the planners or the group leader.

It is also best if these roles are changed on each project so that everyone has a chance to experience each role. Consequently, each project report should indicate what role each group member filled and, if possible, the parts of the project that were completed by each person.

You may wish to modify the above roles to suit your own course. For example, the two planners might become designers in an engineering course, experimenters in a chemistry course, or interviewers in a social science project.

Dealing With Group Problems

Our experiences show that for any number of reasons most students are willing to let all kinds of problems exist within their groups rather than try to resolve those problems. In some cases the students just don't know how to deal with the problems. In others, there often seems to be a "let sleeping dogs lie" mentality within the group that prevents members from forcing problems out into the open. These groups often prefer to continue working with anger and frustration just under the surface. Usually this leads to a rather negative group experience.

We've found that it's best if you can help these groups to bring their problems into the open and deal with them. One simple approach is to encourage group members to bring their problems to you. As we mentioned in the chapter on transition, it's a good idea to let your students know that they will probably have some problems in their groups and that this is just part of the normal process. However, you should also indicate that they should talk to you if these problems appear to be getting out of hand.

When students do come to talk with us we try to encourage (and sometimes demand) that the entire group should meet with us. This way we can get all sides of the issue and bring everything out into the open at once. Usually problems are caused by a lack of communication among group members. We usually try to act as a mediator in these situations, encouraging everyone to express his or her feelings. Once the problem has been determined, we also try to lead the group through a decision-making process to develop a problem solution that the entire group agrees on. This may involve deciding what each person's fair share of the work will be or determining group meeting times that are acceptable to everyone.

In *Grading* we discuss some ways of using peer evaluations to help expose group problems. Whether you follow this approach or not, it is usually a good idea to be aware of the group problems that may arise and to develop ways of bringing these into the open so they can be handled effectively.

Group Divorce

There are also two other issues you should consider before your course starts: Will you allow groups to split up? Will students be allowed to work alone? Almost invariably, we have found that one group in every class will decide that it wants to split up due to "irreconcilable differences." We also find students who indicate they cannot work in groups, but will be glad to do the projects on their own. How you deal with these situations is up to you, but we have some thoughts you might want to consider.

In the past, we have allowed groups to split up into two new groups. This has always led to one new group that did about as well as the old group had done and one new group that does very badly. Apparently, the strong group members have jettisoned their weaker colleagues. The approach we follow now is to only allow groups to split if all group members can be absorbed by other groups. This at least ensures that the weak group members will not be left on their own. However, this has not always been satisfactory. Some people who use Guided Design indicate from the very beginning that groups must stay together. Their feeling is that this helps force the groups to solve their problems, something that will help them handle problems later in life. This approach has merit and, to be honest, we are leaning more and more in that direction.

We have also allowed several students to work alone on the Guided Design projects. Again, the results that these students generated were almost invariably not as good as those generated by the groups. As a result, we have decided that group work is such an important part of Guided Design that no one is allowed to work alone. Of course, we still get the occasional student who indicates they are going to open a one-person business after graduation and that they don't need to learn how to work in a group. We haven't bought that argument yet.

LECTURES

Clearly, lectures are one of the most common instructional strategies in higher education. In our Guided Design approach they are one of the least common elements. Because we rely on the self-instruction units for the transfer of information and use the usual class time for group work, there is little time or need for the traditional lecture approach. However, we have found that lectures can serve a useful purpose for the course in certain areas: motivation and information.

Motivational Lectures

Somewhere around the middle of the semester you will begin to hear the students asking "So what?" Despite your best intentions to build your course around real world experiences (See *Rationale*) students will inevitably begin to wonder if all of this really does work. About this time you should bring the whole class together for two reasons: they are beginning to feel isolated and they need to be recharged.

The students often feel isolated, especially if you are dealing with a large lecture group split into several smaller units, in that they are always working with only a small part of the class (their group). Such a situation often causes students to wonder if they are really doing what everyone else is doing. You can help ease this anxiety by bringing the entire class together to summarize progress to date and solicit questions. You should, however, spend less than 20 minutes on this aspect of the lecture period.

The remainder of the time should be spent showing them the value of Guided Design. We have done this by developing a lecture that presents a real world problem of some novelty and illustrating how the Guided Design process was used to solve the problem. (These can be found in case studies, or even better, personal consulting experiences.) A well chosen problem can motivate the students. And if the problem is interesting enough you won't have to worry about playing Johhny Carson to a bunch of bored students.

Another alternative to the occasional lecture is a fixed lecture time. We have also had success with a motivational lecture at the start of each major unit of the course, e.g., in Figure 5.1 you will see that we have placed several such lectures throughout the course.

Informational Lectures

The primary purpose of the informational lecture is to clarify content. Sometimes we will combine this type of lecture with a motivational lecture that precedes a new topic (as we just discussed). In the informational lecture we might provide the student with an overview of the technique we are introducing and point out common problems with the unit. However, the informational lecture is most efficient when you find that many groups are becoming bogged down over the same problem. At this point, instead of repeating the same explanations over and over, you ought to consider calling the class together and dealing with the specific problem. In this instance, we would prepare a full period lecture dealing with the problem, e.g., conceptual underpinnings of multiple regression, the problems of verifying primary sources in history, etc.

GRADING

There will usually be several components that constitute the grade in a Guided Design course. For instance, these may be quizzes, exams, and the group projects. The weight you put on each component should reflect the emphasis you want placed on each by the students and should indicate to them how seriously each component should be taken.

As an example, in our course we weight the quizzes 5%, the exams 50%, and the group project grades 45%. For one thing, this weighting helps to reduce student criticisms that the course is too heavily group oriented since over half of their grade is based on individual tests (quizzes plus exams).

The actual weight you place on each item and the way you want to grade them are up to you. However, we have presented some ideas below that you might want to consider.

Quizzes

We use quizzes to ensure that students have at least skimmed over the course content material that will be covered by a given project. Thus, the quizzes we give cover only basic concepts and definitions related to the material. Likewise, the weight given to quizzes is not high, but is still enough that it can affect someone's grade in the course. We limit the quizzes to five questions and allow five minutes or less for the students to answer.

Tests

As we've mentionied earlier (see *Scheduling*), we give exams right after completion of the projects since this seems to be the time when students are freshest on the material. Thus, we expect that they should know the content material thoroughly. Most exam questions are very specific and require the detailed use of all content material and techniques.

We also ask several questions that either deal specifically with the project or that require the use of techniques that had to be used in solving the project problem. This is a check on those who have or have not contributed on the projects, encourages everyone to know what is going on with the projects, and also rewards those who have not only worked on the project but who also learned from that work. It also stresses to the students that what they learn working on the group projects can be useful elsewhere.

Because these tests are all-inclusive, we usually have 20 or 25 questions and allow 50 minutes for their completion. Of course, these may vary depending upon your course and the type of questions.

Group Projects

Grading of projects can be a very difficult process. For one thing, it's hard to know what criteria to use. While a test question can be either right or wrong, the solutions to an open-ended problem fall somewhere in between. While Guided Design projects may not have one right answer, some answers may require only a surface examination of the problem and may have only short-term effects. Another solution may take detailed examination and research, but will have much longer-lasting effects. In cases like this, we tend to grade the second type of solution more favorably.

One thing that helps in grading group projects is to define your expectations ahead of time. How detailed do you expect the solutions to be? What concepts or techniques should be applied? How well should the solution be justified? Do you expect the students to utilize outside resources? Should they use the computer in their work? It is also a good idea to communicate these expectations to the student. (Appendix D contains samples of project guidelines.)

Peer Evaluations

We have already discussed the peer evaluation process in *Group Dynamics*. However, there are a few additional points that should be considered regarding its use in your grading scheme.

We use peer evaluations so that we can differentiate among students according to their work on the projects and so that students can begin to learn to evaluate the work of their colleagues. However, some people also argue just as reasonably that everyone in the group should share equally in the project grade and that peer evaluations can lead to dissension in the group. You can decide which argument you prefer.

In using peer evaluations, we let students keep their ratings of others confidential. The only information we divulge is the grade each person receives based on these evaluations. It is our opinion that students will be more honest in their evaluations of colleagues if they know that the ratings will be kept confidential. However, many instructors feel that open discussion is important and that the whole group should decide how many points each person will receive.

This approach can work well but may also require you to pay more attention to group dynamics in general.

PEER RATING SYSTEMS.

Here is a rating system we have used with some success:

- Give each student 100 points to divide among each of his or her fellow group members according to their contribution to the project. (See Appendix B)
- Add up the total number of points each person receives from his or her fellow group members.
- Determine the highest number of points received by any one of the group members.
- Divide each person's total points by the highest number of points received by any group member.
- Multiply the ratio calculated from Step #4 by the group's report grade. For example, if the following group's report received a grade of 80, each group member's grade would be as shown:

Member	Points Received	Ratio	Grade
Bill	110	110/120 x 80 =	73
Jill	90	90/120 x 80 =	60
Will	80	80/120 x 80 =	53
Samantha	120	120/120 x 80 =	80

You should see that this formula allows no individual to receive a grade higher than the group's project report grade. If the denominator is changed to 100, you will then create a scheme where someone can receive a grade higher than the group grade. Again, the choice will need to be made based on your own teaching philosophy.

If a group's peer evaluations vary by more than 20 points (from highest to lowest), we require that the group schedule an appointment to discuss this point spread. We have found that requiring the entire group to discuss their feelings can help resolve problems. In the group above, Bill and Samantha might feel that Jill and Will weren't doing their fair share. On the other hand, some groups will be content to have certain group members do more and get higher grades.

However, it is important to determine that everyone agrees on individual responsibilities to avoid problems later. We also allow group members to alter their peer evaluations after the group conference. Sometimes low evaluations are given in anger without rationally considering their impact.

There are at least two ways you or your students may choose to handle peer evaluations: "do rock" and "don't rock" the boat. In a "don't rock the boat" attitude most students seem to prefer letting others get by with less work while giving everyone equal ratings. In our course, we have let this happen (although we don't encourage it) because we felt that groups that did this had made a conscious decision to do so.

On the other hand, with a "do rock the boat" attitude students may learn more by being forced to evaluate each other honestly. Some instructors require students to rank each other in terms of their contributions to the project. Obviously, since not everyone can be ranked the same, the ratings must differ. Another approach is to insist that the ratings of fellow group members must differ by X number of points. This also forces students to rate each other differentially.

RECORD KEEPING

One reason for keeping good track of grades is the fact that peer evaluations will often mean each student in a project group will receive a different grade. It's important that each of the students be aware soon after the completion of the project just how their fellow team members have evaluated their work. Students who have been evaluated highly can see the results of their extra work and are likely to continue that on subsequent projects. Students who have been evaluated more critically are likely to change their behavior on the next project if they can see right away that it adversely affects their grades.

Peer Evaluation Backup

You may also wish to maintain attendance records as part of your course record-keeping. This can serve two purposes. First, it lets students know that you are aware whether or not they are in class. Second, it can provide backup for the peer evaluations. A group that has rated a member poorly may feel that if this can be supported by class attendance records that indicate that the student was seldom in class to work on the project, then the poorly-rated student has little grounds for disagreement.

Computer Programs

For small classes you may prefer to keep class records by hand. We have found, however, that with large classes, the computer can be a real timesaver. A computer program that we use to record class grades is included in Appendix C. This FORTRAN program ties in with another program that will print out that information. Spread sheet programs such as Lotus 1-2-3 or Visicalc can also be easily adapted to class record-keeping. Just be sure you maintain a backup copy so all your grades don't get lost in case of an accident.

CHAPTER 6

KEEPING THE COURSE ALIVE

Introduction
Accepting the Innovation
  The Change Process
  Facilitating Adoption
People and Change
  Roles and Change
  The Lay of the Land
Common Issues in Implementation
  Student Evaluations
  Student Attitudes
  Faculty Attitudes

Introduction

By the time you have developed and implemented a Guided Design course you will no doubt have noticed that your educational institution has, at best, tolerated your efforts. Most educational institutions, especially universities, are resistant to change and innovation. Studies have shown that faculty hold a conservative orientation toward educational innovation, that the perceived risks of change outweigh the perceived rewards, that the institution does not support change either through its reward system, e.g., promotion and tenure, or through its resources, e.g., faculty release time and graduate assistants. Nonetheless, having introduced your innovation within this culture, you are probably interested in seeing that your course can grow and flower rather than wither away.

In this chapter we will review some of the basic concerns of the change process. By understanding the change process we hope you will be better able to anticipate and manage the concerns of your colleagues. The model we will use is taken from Ronald Havelock's *The Change Agent's Guide to Innovation and Education*. Published in 1973, the book remains a concise introduction to the problems of creating and maintaining innovations in education. Within this model, we will add several of the more specific problems we have encountered with our own Guided Design course.

ACCEPTING THE INNOVATION

If you think about your own interest in Guided Design, you will probably find that you moved through several stages beginning with your initial awareness about Guided Design and ending with your decision to make it part of your teaching repertoire. It isn't our purpose to introduce you to these stages and expect that you will immediately act as a change agent to convert your entire department's curriculum to a Guided Design approach. Rather, we have found that it is useful to be aware of how people come to accept change and to understand that your colleagues will ask different types of questions depending on their stage in the adoption process. The stages researchers have identified are: awareness, interest, evaluation, trial, adoption, integration.

The Change Process

AWARENESS

Initially a person either has no knowledge of a new idea or technique or at most a passing notion that some alternative is available. A person at this stage is best characterized as passive with regard to the innovation, i.e., you will need to bring them information to expand their horizons or to pique their curiousity.

INTEREST

In this stage a person moves beyond passive acquisition of information to a more active stance. They are now aware of the innovation and are willing to consider it. During this stage an individual will gather information to learn more about the innovation. As that information base is developed, the first important attitudes toward the innovation are formed. For some, the innovation will be rejected for any number of overt or covert reasons. For others, the innovation will seem sufficiently worthwhile that it deserves further consideration.

EVALUATION

The evaluation stage is a time when the person considering adopting an innovation conducts a "mental trial." During this period the individual tries to imagine what it would be like to implement some new idea or process in their own lives. Doubts about the innovation will probably be identified more specifically than before. There will be an increased interest in seeing an example of the innovation as it might be practiced by the individual considering it.

TRIAL

At this point the individual has decided to try the innovation at some level. There is not yet a commitment to the innovation, but a sense of its potential worth that deserves some empirical experience. The individual will need guidance from someone with experience in the innovation to help smooth the way, avoid pitfalls, and thus give the innovation a fair test.

ADOPTION

This is the final point of consideration. Whether or not the trial experience was an outright success is less important than an understanding of what went right and what went wrong. To be sure, it helps if everything goes perfectly. However, if the potential adopter can see the reasons and probable solutions for the problems that were encountered, then there is still a good chance the innovation will be accepted. On the other hand, for whatever reason, the individual may not choose to accept the innovation. They may fully dislike it, they may feel "it's OK for you, but not for me," or simply thank you for your time and file away the experience.

INTEGRATION

Once the adoption of the innovation has taken place there is a real need to nurture the change so that it can become an integral part of the organization. The new adopter will need collegial support, additional guidance, recognition, and/or personal rewards from the students, the institution, or the profession. (Havelock, 1973, 113-117)

Facilitating Adoption

As you might imagine, people will tend to seek different kinds of information and experiences at the different stages of the adoption process. You can help your colleagues understand your innovation by first deciding about what stage they are in and then tailoring your activities to match the stage.

AWARENESS

A first encounter with Guided Design should be brief, interesting, and easy to understand. You might circulate the *Guided Design Newsletter* to others in your department, route an interesting article on Guided Design, or share some of your own experiences with others at parties or during hallway discussions.

INTEREST

As your colleagues become aware that you are doing "something different" you might begin to receive requests for more information. At this stage you would provide more detailed information to those who request it. You might present your work at a Faculty Development Seminar, you could order the film on Guided Design (no charge) from Modern Talking Picture Service, you could provide a more detailed reading list for those so inclined. In general, one of the most useful things to do at this stage is to promote discussion of Guided Design. People will ask questions, voice doubts, show excitement. All of these events are healthy and necessary in the change process.

EVALUATION

The thinking and talking from the Interest stage will continue into the Evaluation stage, but there is now more of a need to experience the innovation. You might invite a colleague who is at this stage to come and observe a unit in the course that is typical of how Guided Design operates. You might also encourage the faculty member to talk with students in the course. You could also encourage others to take advantage of one of the regional workshops offered through the National Center for Guided Design or to talk with others who have implemented Guided Design.

TRIAL

We doubt you will find someone who wants to begin with a full course trial of Guided Design. Rather, what you might expect is an interest in developing a single unit that would be taught within a current course. At this point you will need to work with this individual to help them construct the unit as well as to help with its implementation. If at all possible you should be in the classroom when the unit is introduced so that you can help guide its implementation as well as interpret events for the instructor, e.g., the students were initially confused about how the group was to be run, but they were able to resolve these problems when you clarified the different roles they would each have.

ADOPTION

If an individual has come this far they now face the prospect of making a "go-no go" decision. Probably the biggest obstacle at this point for someone who wants to develop a complete Guided Design course is finding the time to create the materials. You should encourage the department to support this innovation through release time during a semester or help seek internal or external funding for this work. Failing this, you could encourage the faculty member to develop the units on a piecemeal basis, adding a bit each semester until the whole has been achieved.

INTEGRATION

For the innovation to remain the individual will need positive strokes. This may come through professional presentations or publications on the course. A professional involvement with others who value Guided Design will also provide peer support for the continued use of Guided Design. Figure 6.1 summarizes these stages and their associated roles and activities.

PEOPLE AND CHANGE

Whenever an innovation is introduced to a group, people tend to respond in certain identifiable patterns. Again, we are not suggesting that you take the role of a change agent and attempt to convince your colleagues that Guided Design needs to be a major part of your department's curriculum. Rather, we think it is useful to understand how people will tend to respond to a new idea; and that this understanding will help you to safely navigate the waters of implementation and acceptance. The types of people you will meet on this final part of your journey are the innovators, middle and late adopters, the resistors, the gatekeepers, the decision makers, and the opinion leaders.

Roles and Change

INNOVATORS AND ADOPTERS

An innovator by definition is someone who is first to adopt an idea. Having paved the way to introduce the idea, the innovator will likely find there are others with varying degrees of interest in the idea. The middle adopters are those who are willing to try out an idea provided there is reasonable evidence the idea is worthwhile. The late adopter will be the last to adopt an innovation. They dislike change and will embrace an innovation only if sufficient pressure is brought to bear upon them. Interestingly enough, if they do implement this innovation they will resist changing from it should a new idea come along.

RESISTORS

The resistors will take an active role in opposing the innovation. They are usually defenders of the status quo. They may defend their position either from firmly held convictions of what is best or from a personal sense of threat by the innovation or the innovator.

GATEKEEPERS

Gatekeepers are people who interface between two systems, e.g., a department chair who controls access to the financial system for the faculty or information to and from the Dean. Depending on the position the gatekeeper holds, he or she can have a significant effect on your success.

Adopter Stages and Change Agent Strategies

If your potential adopter displays these kinds of behavior . . .	then s/he is probably in this stage of adoption . . .	and the appropriate strategy for you to use is . . .	with activities which . . .
• is passive • has little information about Guided Design • doesn't look for information • has little or no opinion about Guided Design	AWARENESS	ADVERTISER	• get attention • are brief • are positive • appeal to the needs of the adopter
• is active • expresses concern about self with regard to Guided Design • asks questions that relate to self and Guided Design	INTEREST	COUNSELOR	• identify adopter concerns • answer questions • provide relevant information • give reliable information
• is active • asks questions that relate to implementation in own situation	EVALUATION	DEMONSTRATOR	• provide a relevant example • promote discussion with satisfied peer adopters • demonstrate use in adopter-like situation
• is active • is learning how-to • has opinions/concerns about own use	TRIAL	INSTRUCTOR	• train in skills/knowledge • provide feedback • reinforce/support
• is active • asks questions that relate to details of implementation • integrates into work routine	ADOPTION and INTEGRATION	TECHNICAL ASSISTANT	• maintain contact with adopter • link with follow-up resources • provide support • provide rewards

Figure 6.1. Adopter Stages and Change Agent Strategies. Adopted from Diane Dormant, 1986.

DECISION MAKERS

The decision makers hold formal or informal power to decide issues that have an effect on the group. The most common decision maker in the university is the department chair.

OPINION LEADERS

The opinion leaders are probably one of the most important constituencies you will encounter. These people are informally recognized by the group as having a high degree of credibility within their area of expertise. Opinion leaders will typically not be the first people to adopt an innovation; rather they will listen to both innovators and resistors before making a decision. As Havelock notes "their continuance in power rests upon their ability to judge innovations. They want to be champions of an innovation whose time has come." (p. 120)

The Lay of the Land

Having decided to adopt a Guided Design approach, and with a basic understanding of change, you can begin to predict how people will react to you and your new project. While nobody is likely to interfere with your approach to teaching, your colleagues can make life considerably easier or more difficult for you.

The first person you will likely interact with will be the department chair. As a gatekeeper and formal decision maker this person controls access to resources you may need, e.g., duplicating, graduate assistants, release time. Further, this person will probably be integral in promotion and merit processes. Your first hope is that the chair is not a resistor. If so, you will need to tread carefully while making minimal requests for resources. At the same time you should then look for opinion leaders who are sympathetic to your interests and seek their support in your efforts with the chair.

Don't try to convert the resistors or the late adopters. Your efforts and energy should be shared with the middle adopters and the opinion leaders. Avoid battles with the resistors. It is best to view them, as Havelock might urge, as members who provide a useful role in social systems by "resisting intrusions from alien influences, they are the antibodies in our social blood stream." (p. 120)

Pay attention to the gatekeepers. It is easy to remember the role of the department chair, but just as important are the secretaries who control word processing, duplicating, and any number of other services you will need. So too, a smooth relationship with the person responsible for scheduling rooms will help you should you need to divide the class session between large lectures and small group work.

COMMON ISSUES IN IMPLEMENTATION

If, by using Guided Design, you expect that everyone will be pleased with your efforts you will probably be disappointed. Both faculty and students will tend to raise issues that you should anticipate and prepare to deal with. Roughly, we have grouped these issues into three categories: student evaluations, student attitudes, and faculty attitudes.

Student Evaluations

Students, like so many others, don't like change and resist it strongly. The standard lecture approach is so widely used that most college students have become experts at playing whatever games are necessary to maximize their grades. Guided Design, on the other hand, changes a lot of the rules. As we pointed out in the Transition chapter, the student response to these changes is likely to be one of anger and frustration.

Although we have had many students comment on how much they enjoyed the course, most have still said they felt that something was missing without lectures. Let's face it, most students have become accustomed to sitting in a class and being entertained for an hour without having to do much work themselves. Making them spend that time doing something that requires preparation, hard work, and that can often lead to interpersonal conflicts won't please many students.

There is also the problem that most standardized course evaluation instruments are aimed at lecture classes. Most course evaluation instruments are loaded so that they either ask questions that are irrelevant for a Guided Design class or, worse yet, they are slanted so that the best aspects of Guided Design are never evaluated.

After receiving mediocre evaluations using our university's standardized course rating questionnaire, we have developed our own that concentrates on the specific aspects of our course that are relevant. These evaluations have been much more worthwhile and useful. However, we still have not pleased everyone who took the course and the student response still is not as strong as for a lecture course in which the instructor can successfully combine Johnny Carson with Carl Sagan. The use of a specialized evaluation form may become an issue in promotion, tenure, or merit, with colleagues who want to know why you didn't use a standardized university form. In these instances we have taken the time to brief the responsible committee, through a memo or discussion, that some standardized form is not an appropriate measure for this type of course in that standard forms tend to focus on the execution of the traditional lecture/discussion techniques.

Student Attitudes

Some of the common complaints we get and our responses to them are as follows:

We want you to lecture to us.

> You learn just as much if not more from the self-instruction. It's more important to use class time for project work and to learn to work together.

I don't like working in a group.

> One reason you're here in college is to learn things that will prepare you for work after graduation. Unless you plan to become a hermit (which doesn't pay too well) you'll have to work in groups. If you learn here how to deal with groups, you'll be ahead on the job.

This course is too easy.

> (Yes, believe it or not, we get this complaint). It just seems easy because of the self-instruction and the fact that you get to apply your knowledge instead of just memorizing. Actually, you have learned more than students in comparable lecture classes. (We have the data to prove it!)

I don't like having to evaluate my peers or have them evaluate me.

> On the job, you'll have to evaluate others and they'll evaluate you. Again, we're preparing you to be successful in your career. You also are in a much better position than we are to evaluate how much your group contributed to the project.

Faculty Attitudes

Most faculty have come up through the same educational system as our students. Consequently, they are also oriented toward the usual lecture type of class. In addition, many faculty have a very large investment in the lecture approach. They have probably spent years developing their notes and perfecting their teaching style to obtain a certain desired student response. A new approach like Guided Design can be even more threatening to them than to the students.

The idea that students can learn course material without sitting and listening to the instructor may lead some faculty to fear that their jobs might no longer be needed; they can be replaced by a self-instruction book. However, the point that most faculty miss, and that we try to stress to them, is that the self-instruction book is like a lecture, only better. We indicate that the book was developed by us and that it contains as much of us, if not more, than what we would display in lectures. Unlike a lecture, however, students cannot miss material when their attention wanders. In addition, the self-instruction material can frequently check student learning and indicate when students need to re-read a certain section. During a lecture, this frequent checking of all students just is not possible.

We also defend Guided Design to our colleagues by pointing out that the best thing we can do for our students is to prepare them to solve the kinds of real problems they will face after graduation. A lecture cannot do this. With Guided Design the faculty are available to work with groups as consultants, advisors, and guides. Guided Design enables students to not only learn course content material, but also learn how to apply that material. The instructor can be more than just a reciter of content material; he or she can spend class time in the much more important role of mentor.

Epilogue

I had been given written directions on how to go, detailed directions, but have you ever noticed that instructions from one who knows the country gets you more lost than you are, even when they are accurate? (p. 49)

-*John Steinbeck*, Travels with Charley

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APPENDICES

Appendix A
Transition Materials
Appendix B
Peer Evaluation Forms
Appendix C
FORTRAN Program for Class Record Keeping
Appendix D
Sample Guidelines for Project Grading

The Authors allow reproduction of any material in this section for classroom purposes

APPENDIX A

Transition Materials

Group Exercises
Decision Making Self-Instruction Unit
Introductory Project: The Ajax Company

No human being has more than five million hairs on his head. This fact plus some information that the Bureau of Census can provide would permit you to prove that there are at least two persons in New York City who have the same number of hairs on their heads. What information would you need and how could it be used to prove the proposition?

A stranger bought a bicycle for $15 and gave in payment a check for $25. The dealer went to a neighboring store and cashed the check. The stranger received $10 change, mounted his bicycle, and disappeared. The check bounced and the dealer had to make good. The bicycle cost the dealer $11. How much money did he lose altogether?

SITUATION

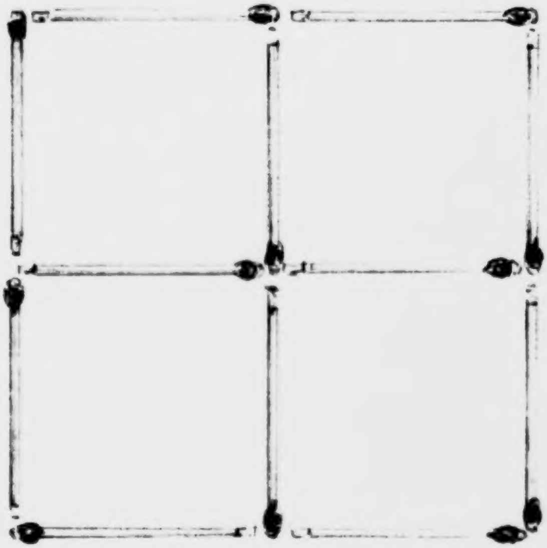
A businessman had just turned off the lights in the store when a man appeared and demanded money. The owner opened a cash register. The contents of the cash register were scooped up, and the man sped away. A member of the police force was notified promptly.

Circle a T if a statement below is true based on the above situation, F if it is false or ? if you cannot tell whether it is true or false based on the above information.

Statements about the story

1. A man appeared after the owner had turned off his store lights. T F ?
2. The robber was a **man.** T F ?
3. A man did not demand money. T F ?
4. The man who opened the cash register was the owner. T F ?
5. The store owner scooped up the contents of the cash register and ran away. T F ?
6. Someone opened a cash register. T F ?
7. After the man who demanded the money scooped up the contents of the cash register, he ran away. T F ?
8. While the cash register contained money, the story does **not** state **how much.** T F ?
9. The robber demanded money of the owner. T F ?
10. The story concerns a series of events in which only three persons are referred to: the owner of the store, a man who demanded money, and a member of the police force. T F ?
11. The following events in the story are true: someone demanded money, a cash register was opened, its contents were scooped up, and a man dashed out of the store. T F ?

The four squares below are made up of 12 matches. Make a drawing to show how by moving only three of the matches you can make only three squares, all of which will be the same size as the original square.



GROUP DEVELOPMENT PROJECT*

Previously, your group participated in a number of cases and exercises. Now, it is time to assess the status of the group **as a work unit**, and to take action designed to increase both its task performance and the satisfaction of its members. The mechanism through which you can accomplish these goals is described below as the "Group Development Project."

Due Date: The final summary report on the group development project is due during the week of __________ and at a time mutually agreed upon between the group and your instructor.

Project Details

The group is to complete each of the development activities described below. Then, a meeting is to be scheduled with your instructor at a place of **your choosing.** During this meeting the group will be expected to communicate the results of the project activities in terms of both 1) a group assessment summary, and 2) a set of future action plans. No written report is required. However, visual aids to improve communications during the meeting will certainly be useful. A final evaluation will be made by the instructor according to,

-the apparent completeness with which the project activities were accomplished.

-the ability of the group to communicate the results of its assessment and planning efforts and,

-the quality of the assessment and action plans.

Activity #1

Prepare the "Background Preparation" part of the "Group Development Project". Ascertain where the group has progressed according to or different from your original expectations. Identify the implications of this analysis. Reestablish priorities, expectations, and goals where appropriate.

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* Modified from John R. Schermerhorn, Jr. as an instructional exercise. Used with permission of the author.

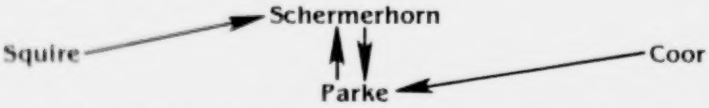
Activity #2

Each member of the group should complete the attached "Team Development Scale." Summarize these responses using appropriate descriptive statistics. Assess the meaning of the data in terms of group development. Use these results constructively.

Activity #3

Prepare **two** group sociograms. One sociogram should reflect member responses to the question, "who is the most influential person in terms of group **task** concerns?" The second sociogram should reflect the question, "who is the most influential person in terms of group **maintenance** concerns?"

A sample sociogram is diagrammed below. To make a sociogram, have each member choose one or more persons in response to each question. Then draw arrows from each member **to** the persons chosen. The result is a diagram such as the following:



Analyze the implications of your two sociograms for group functioning. Use the sociogram information as part of your group development effort.

Activity #4

Consider your group to be an open system with two outputs—task performance and member satisfaction. Use the following outline as an aid for analyzing how these two outputs are affected by the nature of your group's inputs and operational structure.

A. Inputs:

In respect to inputs, focus on the impact on group performance and satisfaction caused by the nature of the tasks faced and differential traits, backgrounds, needs and values of group members.

B. Operational Structure

In respect to group operations, consider the impact on group performance and satisfaction caused by norms, cohesion, group maintenance and task roles, communications, decision-making and conflict. Relevant questions include:

1) What **norms** emerged in the group? How did these norms relate to the task at hand? How were they perceived by various group members? How did they influence group performance?

2) What level of **cohesiveness** was achieved in the group? What factors determined this level of cohesiveness? How did this level of cohesiveness influence group performance?

3) To what extent were group task and maintenance roles performed during the various phases of the group experience? Who performed these roles at various times? Why? To what degree of effectiveness? How did the ability of the group to account for these task and maintenance roles influence group performance?

4) How would you characterize the quality and levels of **interpersonal communications** in the group? What were some of the primary barriers and/or facilitators? How did interpersonal communications influence group performance?

What **communications network** or structure was implemented by the group to accomplish its tasks? How did the communications structure influence group outcomes?

5) How were **decisions** made in your group? Were they decisions by majority, minority, vote, or consensus? How did the various members feel about certain key decisions? Was there an identifiable pattern for your decision-making activities?

C. Outputs

The group should recognize that the type of analysis detailed above requires some determination of what its actual performance to date has been. **As a group** you should consider the productivity question and decide where you came out. Was your productivity high or low and why?

As individuals you must also contribute to the group some measure of individual satisfaction. Are group members satisfied with what has been accomplished and with what is taking place? Why?

Analyze how these input-operations-output factors have changed for your group over time as you pass through the various stages of group development outlined in lecture and/or the text.

Use the results of this activity to make constructive changes in the group's inputs and/or operational structure.

Activity #5

Each member should **write** a personal contract with the group stating what he/she will a) do more of, b) do less of, and c) continue to do in order to insure the success of the group in its remaining work during the course. These contracts should be shared, discussed, and then modified to obtain maximum relevancy.

Background Preparation—Group Development Project

1. Biographies

Prepare a brief written biographical sketch of each member. Concentrate on factors which you judge to be relevant to the operation of your group.

2. Sharing Priorities

Use the diagram below to mark the point from 0 to 100 that identifies where this group stood initially in terms of your total work requirements and priorities. For example, you might say that the group had only a very minor priority (e.g., 10) based on your other time commitments. On the other hand, the possible learning value of the group may have seemed very high to you and thus there would be a score of 90.

Also write in the blank space below the diagram the total number of hours you have been able to allocate to group activities in a typical week.

0 50 100

Zero Priority Highest Priority

Number of hours available per week __________

Now share your priority and number of available work hours with the other members of the group. Each of you should explain why you made the choices you did, and discuss their implications in terms of the group tasks.

Tabulation. Someone in the group should tabulate the results for each individual. A summary diagram showing the priority points for each group member should be prepared.

Also, the frequency distribution of hours available, the total number hours available, and the average number of hours available per person should be listed.

3. Sharing Expectations

Take five minutes to think about the group, its past and future and your place in it. Try to answer the following questions:

What did you want as a result of participating?
What worries did you have about the group?
What did you think the group should do originally to ensure the most positive outcomes?

Now share your answers with those of the other group members. Be sure to express yourself clearly, and to listen carefully to what others are saying. Try to make sure that everyone participates and that you learn as much about one another's views as possible.

Tabulation. Someone in the group should summarize the thoughts shared during this phase of the exercise. Every comment need not be listed, but the range of ideas and general mood of the group members should be fully expressed.

4. The Group Goal

Now it is time to clarify the group's purpose. Obviously, you are part of a group because the instructor requires it. What do you think the ultimate goal of the group should be, however, as it faces its formally assigned tasks? Write your goal statement in the space below. Specify the goal of the group as you originally saw it. Write that in the space below.

Share your goal statement with the other group members. As a group, prepare a summary of the group's original goal.

Tabulation. Someone in the group should write down the formal statement of the group's original goal.

Team Development Scale
by William G. Dyner

1. To what extent do I feel a real part of the team?

1	2	3	4	5
Completely a part all the time	A part most of the time	On the edge sometimes in sometimes out	Generally outside, except for one or two short periods	On the outside, not of the team

2. How safe is it in this team to be at ease, relaxed, and myself?

1	2	3	4	5
I feel perfectly safe to be myself, they won't hold mistakes against me	I feel most people would accept me if I were completely my self, but there are some I am not sure about	Generally, you have to be careful about what you say and do in this team	I am quite fearful about being completely myself in this team	A person would be a fool to be himself in this team

3. To what extent do I feel "under wraps," that is, have private thoughts, unspoken reservations, or unexpressed feelings and opinions that I have not felt comfortable bringing out into the open?

1	2	3	4	5
Almost completely under wraps	Under wraps many times	Slightly more free and expressive than under wraps	Quite free & expressive much of the time	Almost completely free and expressive

4. How effective are we, in our team, in getting out and using the ideas, opinions, and information of all team members in making decisions?

1	2	3	4	5
We don't really encourage everyone to share their ideas, opinions, and information with the team in making decisions	Only the ideas opinions, and information of a few members are really known and used in making decisions	Sometimes we hear the views of most members before making decisions and sometimes we disregard most members	A few are sometimes hesitant about stating their opinions, but we generally have good participation in making decisions	Everyone feels his/her ideas opinions, & information are given a fair hearing before decisions are made

5. To what extent are the goals the team is working toward understood and to what extent do they have meaning for you?

1	2	3	4	5
I feel extremely good about goals of our team	I feel fairly good, but some things are not too clear or meaningful	A few things we are doing are clear and meaningful	Much of the activity is not clear or meaningful to me	I really do not understand or feel involved in the goals of the team

6. How well does the team work at its task?

1	2	3	4	5
Coasts, loafs, makes no progress	Makes a little progress.	Progress is slow, spurts of effective work	Above average in progress and pace of work	Works well, achieves definite progress

7. Our planning and the way we operate as a team is largely influenced by:

1	2	3	4	5
One or two team members	A clique	Shifts from one person or clique to another	Shared by most of the members, some left out	Shared by members of the team

8. What is the level of responsibility for work in our team?

1	2	3	4	5
Each person assumes responsibility for getting work done	A majority of the members assume responsibility for getting the work done	About half assume responsibility, about half do not	Only a few assume responsibility for getting the work done	Nobody, (except maybe 1) really assumes responsibility for getting the work done

9. How are differences or conflicts handled in our team?

1	2	3	4	5
One or two differences or conflicts are denied, supressed, or avoided at all cost	Differences or conflicts are recognized but remain unresolved mostly	Differences or conflicts are recognized and some attempts are made to work them through by some members, often outside the team meetings	Differences and conflicts are recognized and some attempts are made to deal with them in our team	Differences and conflicts are recognized and the team usually is working them through satisfactorily

Decision Making
Self Instruction Unit

After completing this material you should be able to:

I. List the Four Steps of Decision-Making.
II. Explain Why it is Important to Define a Problem First.
III. Describe the Difference Between Problem Causes and Problem Symptoms.
IV. State the Characteristics of a Good Objective.
V. Describe the Difference Between Facts and Constraints.
VI. Describe the Role of Assumptions.
VII. Explain the Process of Brainstorming to Develop Possible Solutions.
VIII. List the Criteria for Evaluating Solutions.
IX. Describe the Process of Analysis, Synthesis, and Evaluation.

Objective I:

List the Four Steps of Decision-Making

You are probably used to making decisions in your everyday life. However, most of these decisions are made in an emotional, haphazard way. In solving business problems it will be important for you to follow a *systematic* procedure.

This procedure is based on steps developed by decision-making experts. It is guaranteed to lead to better, hard-headed solutions. For now, we will just present the steps, then explain these steps in detail later.

The steps are:

1. Define the problem
2. List constraints, assumptions, and facts.
3. Develop possible solutions and select one.
4. Analyze, synthesize, and evaluate the solution.

It will be important for you to perform these steps automatically. Therefore, we want you to memorize them now. To test your memorization, list them on this page before turning the page to check your answer.

Question 1: What are the four steps of decision-making?

Answer 1: The four steps are:

1. Define the problem
2. List constraints, assumptions, and facts.
3. Develop possible solutions and select one.
4. Analyze, synthesize, and evalute the solution.

If you did not get these correct, go back and memorize them before proceeding.

Objective II: Explain Why it is Important to Define a Problem First

In problem-solving, most people are used to thinking of possible solutions as a first step. However, this is incorrect. Until you have defined the problem, how can you be sure that your solutions will solve it? Stories abound of people who developed perfectly good solutions, but for the wrong problem, or, worse yet, spent huge sums of money trying to solve a non-existent problem. Thus, although it may seem awkward to you, we will stress that you must first define the problem before even thinking of how to solve it. In all the decision-making work for this course you will always define the problem as a first step.

Question 1: Why is it important to define a problem as the first decision-making step? (Write your answer below.)

Answer 1: The reason for defining a problem first is so that you can be sure that you are solving the correct problem.

Objective III: Describe the Difference Between Problem Causes and Symptoms

In order to define a problem you must first be able to recognize the problem. There are two things that will help you do this: causes and symptoms. However, to correctly define the problem it is important that you be able to differntiate between these two.

Problem Symptoms are the signs which indicate a problem exists. For example, when you have a cold the symptoms are a fever, runny nose, and general feeling of being unwell. These indicate that a problem exists, but are not really the problem cause.

Likewise, in a production operation, frequent late deliveries to customers, excessive inventory, or high labor costs may indicate that a problem exists. These are the symptoms. However, the causes are usually something different.

Just as a runny nose and fever are *symptoms* of a cold but not the cause, the causes of a production management problem may be different than the symptoms. For instance, high levels of inventory may be only a symptom which is *caused* by a decrease in demand for the product.

With a cold, the cause is a virus. Its symptoms are runny nose and fever. In a production problem, the cause may be a drop in product demand. The symptom will be a buildup of inventory from the unsold units we have manufactured. *The problem cause produces the symptoms which indicate that a problem exists.*

Question 1: Describe the difference between problem symptoms and causes.

Answer 1: A problem cause is what brings about the problem. The symptoms are the visible signs that a problem exists.

Recognizing problem causes and differentiating them from problem symptoms is something which takes some skill and practice. (However, you will be getting practice later in this class.) You should be aware, though, that sometimes one symptom may cause another symptom. For example, high inventories may cause a cash shortage in the company. In such a case, you need to trace back to the *original cause.*

Objective IV: State the Characteristics of a Good Problem Definition

You may feel that being able to recognize problem causes and symptoms will enable you to solve a problem. Unfortunately, that is not true. For one thing, eliminating symptoms will not solve the problem. Reducing the fever and drying up a runny nose does not cure your cold. It just helps you feel better. Unfortunately, when you're ill, curing the symptoms may make matters worse by masking the signs a physician needs to recognize the real problem. In production management, eliminating symptoms does not solve the problem.

Likewise, knowing the causes may not solve the problem. For instance, during the recession of 1980 many firms noticed an increase in inventories (the symptoms). This was caused by a downturn in sales (the cause). However, due to the general economic conditions they could do little to increase sales. Instead, firms had to concentrate on other ways of solving the problem.

Because symptoms and causes will not lead to a problem solution, although they are helpful in recognizing the problem, there is one last step in defining the problem. That is to state the *objective* of your problem-solving work. In other words, what you want to achieve.

A good objective will describe *what we want to achieve.* However, it will not specify any *particular solution* for achieving it. This is because we still are avoiding problem solutions. Thus, the objective should also be sure to avoid specifying any particular solution. For instance, in the recession problem mentioned above, a company might state its objective as being to reduce its investment in inventory. This could be achieved by either increasing sales or cutting back on production. Thus, the company has specified what is to be achieved, but still kept its options open.

Question 1: For the problem situation described below, which of the following are good objectives and which are not? What is wrong with the ones which are not?

Consider a company whose sales have decreased. It finds too much money is tied up in excessive finished product inventories. For the time being, sales cannot be increased. The objective is:

1. To cut back on production so inventory will decrease.
2. To reduce inventory by increasing sales.
3. To increase profits.
4. To eliminate the problem.
5. To reduce inventory investment.

Answer 1: 3 and 5 are good objectives because they specify *what we want to achieve without specifying how*. However, 3 does not specifically relate to this problem.

1 is just a possible solution while 2 states the objective but specifies how it will be achieved.

4 is too nebulous. It does not *specify* what we want to achieve in the end. Thus, it too is not a good objective.

Question 2: Just to be sure you have them, state the characteristics of a good objective.

Answer 2: A good objective will specify exactly what we want to achieve. It will not state how that will be achieved.

Objective V: Describe the Difference Between Facts and Constraints

After you have identified the symptoms and causes of a problem and stated the objective, you're a long way toward solving the problem. However, there is one more step which needs to be done. That is to identify the facts you know, constraints which will restrict your solutions, and assumptions to be made.

For now, we will just consider facts and constraints. Although they are quite similar, there are some important differences which you should recognize.

Facts are everything we know. For example, in the problem discussed previously relating to inventory we may know the current dollar value of inventory, level of sales, and current production rate. These are all facts.

Constraints are facts which restrict our actions. For example, the current production rate is a fact. However, it is not a constraint because it does not restrict our actions. Suppose, though, that this production rate is governed by an automated assembly line. The speed of this line can be decreased by no more than 10 percent. This is now a *constraint.* That the production rate can be decreased no more than 10 percent is a fact—something we know. However, this fact also means that any solutions involving a decrease in production rate are restricted to 10 percent. Because this fact restricts our solutions it is also a constraint.

Question 1: Describe the difference between facts and constraints.

Answer 1: Facts are everything we know. Constraints are facts which restrict our actions, thereby limiting our possible solutions.

Question 2: A company produces washers and dryers. Finished units are stored in a warehouse. They currently have 400 washers and 200 dryers. The company's objective is to *increase* its inventory. However, the warehouse can hold only 700 total units and the production rate cannot be increased.

What are the constraints and facts?

Answer 2: The facts are:

1. The warehouse contains 400 washers.
2. It contains 200 dryers.

The constraints are:

1. The warehouse can hold only 700 units.
2. Production rate cannot be increased.

Note that the facts just tell us how things are now. Constraints restrict our future actions.

Objective VI: Describe the Role of Assumptions

While facts are what we know and constraints are facts which limit our actions, there is often information which we do not have. For example, we may not know whether sales will continue to be depressed. Likewise, we may not know how the company's union would react to laying off employees. In both of these cases we may have to make an *assumption*.

Assumptions fill in for unknown information. In our daily lives we are constantly making assumptions about events or other people's actions. Most of the time these assumptions are made unconsciously.

In systematic decision-making it is important that you list the assumptions being made. That way you can examine them and determine whether each assumption is reasonable. If you develop solutions based on an unreasonable assumption then these solutions probably will not work.

Question 1: What role do assumptions play in problem-solving?

Answer 1: Assumptions fill in for information we do not know. It is important to list any assumptions we are making in solving a problem.

To give you an idea of what can happen if assumptions are not listed and examined, consider the following story.

One day at lunch, the Chairman of the Board of a large company wondered aloud: "Why don't we have a distribution center in Springfield?" It so happened that the company's biggest customer was in Springfield.

Overhearing this remark, a Vice-President started the ball rolling to get one built. Three years and $6 million later, the Chairman had to order the Springfield distribution center closed because it was such a money-loser. He didn't think one should have been built there, he just wondered why one never was. The Vice-President *assumed* he wanted one there.

Remember, there's an old saying, if you make an assumption without checking it out, you make an ASS out of U and ME.

Objective VII: Explain the Process of Brainstorming to Develop Possible Solutions

So far, we have covered the first two steps of the decision-making process. The first, which is *defining the problem*, includes recognizing symptoms and causes and stating the objective. The second step involves *listing constraints, assumptions, and facts*.

At this point, you are ready to go on to possible solutions. When most people approach a problem they usually pick one particular solution right away. However, this, like not defining the problem first, is a mistake. Instead, it is best to develop as many possible solutions as you can. In this way, you won't miss any good solutions, ones which might be better than your first idea.

One process which has been found useful in developing possible solutions is called *brainstorming*. The idea behind brainstorming is to develop a list of possible solutions without evaluating them. In a later step you will throw out some and evaluate the rest.

To brainstorm you usually need a group of people sitting in a circle. One person should keep track of the solutions. Each person should keep the overall objective in mind, but express whatever possible solutions come to mind. This should be done *without stopping to evaluate solutions*. Most of us filter what we say, asking ourselves, "does this sound dumb?", "Does this project the image of me I want to project?" and so on. In brainstorming you need to just let the ideas flow, turning off that internal filter. It's difficult to do, but that's what leads to good solutions.

To brainstorm, there are four basic rules:

1. No criticism
2. Free-wheeling is welcomed. The wilder the idea the better.
3. Quantity is wanted.
4. Combination and improvement are sought. Suggest ways of improving other ideas.

Question 1: Describe the brainstorming process and list the four rules.

Answer 1: Brainstorming is a process for generating possible solutions. A group of people in a circle generate ideas while one records these ideas. Each person avoids filtering or evaluating these ideas as they arise, but keeps their objective in mind.

The rules are:

1. No criticism
2. Free-wheeling is welcomed. The wilder the idea the better.
3. Quantity is wanted.
4. Combination and improvement are sought. Suggest ways of improving other ideas.

Objective VIII: List the Criteria for Evaluating Solutions

The brainstorming process generates possible solutions without evaluating them. However, it is neccessary after this to narrow these down and to select the one solution you think is best.

In any business situation there are certain criteria which can be used to evaluate possible solutions. You may find that for a given situation you will want to add others. However, for now we will give you a basic set to begin with.

The first criterion is *feasibility*. Does the solution violate the constraints? If so, it may be rejected. This can help to narrow your list.

The second criterion is *cost*. First of all, is the money available for a given solution? If not, that solution can be rejected. Otherwise, you can rate each solution on the basis of high, medium, or low expected cost.

The third criterion is *resources*. Are the resources (plant, people, and equipment) available for each solution? Again, this may allow you to reject some solutions.

The fourth criterion is *ethics*. Is the solution legal, moral, and ethical? Again, if not, the solution should be rejected.

After using these four criteria you will have narrowed down your list of solutions and evaluated the attractiveness of those remaining. At this point, it will be up to you to select the one solution you think will best solve the problem.

Question 1: List the four general criteria for evaluating possible solutions.

Answer 1: The four general criteria are:

1. feasibility
2. cost
3. resources
4. ethics

Objective IX: Describe the Process of Analysis, Synthesis, and Evaluation

After selecting the most attractive solution, the last step involves actually working out the details of that solution.

Analysis refers to analyzing the solution components and details. For example, suppose that to reduce inventory we decide to cut back on the production rate. How will this be done? Will we lay off employees? Will it affect our ordering of raw materials? In the analysis phase you need to figure out what needs to be done in developing your solution.

Synthesis is working out all the details and putting everything together into a detailed solution. For example, if you decide to lay off employees, now is when you compute how many. Any other details are worked out, all calculations are completed and the final solution is developed.

The final phase involves *evaluation* of your solution. Will it solve the problem? Can it be improved? At this point you may want to perform more analysis and synthesis.

Question 1: Describe the steps of analysis, synthesis, and evaluation.

Answer 1: Analysis involves examining a solution, determining the components, and planning for detailed synthesis.

Synthesis is actually working out the details and performing any necessary calculations, then putting the pieces together.

In evaluation, the detailed solution is evaluated and, if necessary, additional work is performed.

POSTTEST

1. A problem cause:
   a. is the outward sign a problem exists.
   b. is what we want to solve.
   c. states our objective.
   d. is what produces the symptoms.
2. A problem symptom
   a. is the outward sign a problem exists.
   b. is what we want to solve.
   c. states our objective.
   d. is what produces the symptoms.
3. Which of the following is a good objective?
   a. To reduce labor costs.
   b. To reduce labor costs by laying off employees.
   c. To lay off some employees.
   d. To solve the problem.
4. It is important to first define the problem because:
   a. then we will get a solution right away.
   b. this will solve the problem.
   c. then we will know whether the right problem is being solved.
   d. defining the problem is not the first step.
5. Which of the following is a *constraint?*
   a. We now have 100 employees.
   b. There is no money to hire more employees.
   c. 30 percent of the employees are over 40 years old.
   d. 40 percent of the employees are women.
6. Which of the following is *not* a rule of brainstorming?
   a. Free-wheeling is welcomed.
   b. No criticism.
   c. Combination and improvement are sought.
   d. Quantity should be kept to a minimum.

7. The criteria for evaluating solutions are:
   a. feasibility, cost, resources, ethics
   b. feasibility, morale, cost, outcome
   c. feasibility, acceptability, performance
   d. usefulness, adaptability, performance

8. Place the following four steps of decision-making in correct order.
   1. Develop possible solutions and select one.
   2. Identify the problem.
   3. List constraints, assumptions, and facts.
   4. Analyze, synthesize, and evaluate the solution.

   a. 1, 2, 3, 4
   b. 2, 1, 3, 4
   c. 2, 4, 1, 3
   d. 2, 3, 1, 4

ADSC 318

Quiz #1 - Decision-Making

1. A problem cause is:
   a. the thing we should solve.
   b. our objective.
   c. what produces symptoms.
   d. the sign that a problem exists.
2. A problem symptom is:
   a. the thing we should solve.
   b. our objective.
   c. what causes the problem.
   d. the sign that a problem exists.
3. Place the four steps of decision-making in correct order.
   1. Develop possible solutions and select one.
   2. List constraints, assumptions, and facts.
   3. Identify the problem.
   4. Analyze, synthesize, and evaluate the solution.

   a. 1,2,3,4,
   b. 3,2,1,4
   c. 1,4,3,2
   d. 2,3,1,4
4. Which of the following is a constraint?
   a. There are 500 employees.
   b. Inventory is now 800 units.
   c. The work day is from 8 a.m. to 5 p.m.
   d. The warehouse has capacity to hold only 900 units.
5. Why is it important to identify the problem?
   a. So we can be sure to solve the correct problem.
   b. To identify the problem causes.
   c. To help us list constraints, assumptions, facts.
   d. So we can alleviate the symptoms.

Introductory Project:
The Ajax Company

You should now be in groups of four people. By now, you should know something about Guided Design, the process of decision-making, and group dynamics. This "practice project" is designed to give you a chance to bring all that together before you form permanent groups and begin work which will count toward your course grade.

This project follows the same sequence of steps as all forthcoming projects, the same steps you learned for the decision-making process. The problem relates to P/OM, but you can solve it using your own common sense. Its purpose is just as an introduction and practice, so relax and pay attention to the steps you follow in solving the problem.

Group Formation

Your group should assign a job to each person as follows:

1 leader
2 planners
1 researcher

Based on the class discussion of group dynamics you should know about what each person's job will be. Keep those jobs for this project. The researcher should also record your response to each instruction.

The Ajax Company:

An Introduction to the Decision-Making Process

The Setting:

It was early one morning when four managers of the Ajax Company met to discuss a problem. Present were: Bill Coscarelli, Production Manager; Sharon Shrock, Data Processing Manager; Constance Coleman, Press Department Supervisor; and Burt Hancock, Plant Manager. Bill started the meeting:

> "Okay Burt, what's the story on the 1487's. How come we're having trouble with those all of a sudden?"
>
> "Well, Bill," Burt replied, "I've asked Constance to be here since the problem's occurring in her department. I'll let her explain."

Constance Coleman, Press Department Supervisor, is a ten year veteran of Ajax. She was recently promoted to supervisor after Bill Gray, the previous Press Department Supervisor for 25 years, took an early retirement. Somewhat awed by the presence of Bill Coscarelli, one of the "big brass" at this meeting, Constance chooses her words carefully:

> "Well Mr. Coscarelli, as you know we usually run about 7% scrap on 1487's. This is mainly because of that part's detail and the problems we have with some of the older presses. In the past, we just added 10% to each shop order to be sure of getting enough good ones. In fact, this usually produced some extras."

(The Ajax Company manufactures tools. One of their products is a snow shovel. The scoop for this is identified as part #1487 and is aluminum which is formed from sheet aluminum under very high pressure on hydraulic presses. These presses shape the aluminum, pressing in the details, and cut off the edges, all in one operation.

The 7% scrap rate means that on part #1487, an average of 7% in each run must be scrapped due to defects. Thus, in a run of 10,000, there would be about 700 scrapped, leaving 9300 good scoops.)

Constance continued:

> "As you know, we've been trying to cut down on overruns as part of the cost reductin program. To do this, we started adding just 7%, the scrap rate, to each order. Now we've begun coming up short."

At this point, Burt Hancock broke in:

"Bill, we've checked and re-checked that scrap rate and they're running right at 7%. Just the same, on a shop order of 10000 last week we ran 10700, but got only 9951 good ones, 49 short.

I can't figure it out. That's why I've asked Sharon to be here. I think we need to computerize this thing."

Sharon Shrock, Data Processing Manager, had just joined the company 6 months before. During that time, top management had been impressed by her problem-solving ability. She is now recognized as an up-and-coming force in the company.

"Burt," Sharon replied, "my department and I are certainly at your service and we'll try to do whatever we can to help. However, I'm not sure what the problem really is."

"It seems pretty obvious to me," Burt said. "We need to computerize this thing."

At this point, Bill Coscarelli broke in:

"Look, whatever the problem is, we need to correct it fast. Marketing is already upset, and you know how anxious they are to jump down my throat every chance they get!"

Instruction 0.1-The Problem

The very first step any professional decision-maker performs in solving a problem is to clearly identify what the problem really is. By doing this you can avoid wasting time solving the wrong problem or just trying to cure the symptoms.

You should state the problem in terms of what you want to achieve. For example, given the problem of adding 2 + 2, one could state the problem as: "to find what 2 + 2 equals."

In our case, you could state the problem as "to reduce the scrap rate." However you define it, be sure to state what you want to achieve.

You should think about this for now, then in class you will combine your ideas with those of others in a group. At that time, you'll be given additional guidance.

Feedback

In this and all other projects we will give you written feedback. It will describe what the person being portrayed in this problem did. DO NOT treat this as a "correct answer." It merely represents a good answer against which to compare your response. Is yours better? Are there strong points about one or the other? How are they the same? Different? Unfortunately, most of your education until now has taught you to look for the "right answer." In solving real problems there is no such thing. However, some problem solutions are better than others. Use this feedback as a guideline only. DO NOT copy it (aside from making yourself liable for copyright infringement, you won't learn anything). Trust your own ideas and do your own work. Feel free to disagree with the feedback when you think your group's response is better, but be prepared to defend your position.

Feedback 0.1

Sharon decided that the previous *over*-production of parts and present *under*-production were both symptoms of the problem. She decided the problem was caused by not starting the proper number of parts into the press operation so as to end up with the correct number of good parts.

Based on this, she decided the objective was "to ensure that just the correct number of good parts are produced."

You should notice that this is a good objective. It states what is to be achieved: to get just the right number of parts, not too many, not too few. It also does not specify *how* it will be done. That is left for *you* to decide.

Instruction 0.2 - Constraints, Assumptions, Facts

You should now go on and list all the important facts, decide which facts will constrain your solution (the constraints) and list any assumptions you are making.

Feedback 0.2

Sharon and her group developed the following list:

Facts

1. The scrap rate on part #1487 is now 7%.
2. Adding 7% to an order of #1487 produces shortages.
3. Adding 10% to an order produces overages.

Constraints

1. The solution must be implementable in a short period of time.

Assumptions

1. The scrap rate will remain at 7%.
2. The scoops cannot be stamped on other equipment.

Compare these to your list and decide where you think there are differences and why. Again, be prepared to defend your list.

Instruction 0.3 · Possible Solutions

Finally, you can think about possible solutions. Even though you may have one in mind, go on and brainstorm. See how many ideas you can come up with. However, your solutions should meet the objective "to ensure that just the correct number of good parts are produced."

After that, go on and select one solution you think is best. Remember, you can use the set of criteria I gave you earlier, adding any others you think are relevant.

Feedback 0.3

Sharon's group listed the following possible solutions:

1. Buy new presses with lower scrap rate.
2. Computerize the calculations of required units.
3. Perform the calculation differently.
4. Hire a new press dept. supervisor.

They evaluated these on the four criteria of cost, resources, feasibility and ethics. Because of the constraint, they also added "speed of implementation."

Solution	Cost	Resources	Feasibility	Ethics	Speed
1. New presses	High	?	?	OK	Slow
2. Computerize	Med.	Yes	Yes	OK	Moderate
3. Different	Low	Yes	Yes	OK	Fast
4. New Super.	Med.	Yes	?	?	Moderate

Based on this, they decided that doing the calculations differently was the best solution.

If you agree, fine. Otherwise defend your solution. If you think it's best then stick with it for the next step.

Instruction 0.4 - Analysis, Synthesis, Evaluation

At this step, you should recall that you analyze the solution, break it into components, and determine the work to be done. In synthesis, you develop the components and put them together. After that, you evaluate the solution and determine whether it has solved the problem, whether it can be improved, or whether more work is needed.

For the solution of changing the calculations, the analysis follows.

The problem was occurring when 7% was added to each order for part #1487. However, 7% of these *extras* will be bad. This was not taken into consideration. Therefore, they came up short.

To synthesize the new solution, let's see how this can be corrected. Let X be the number we need to start. Seven percent of these will be scrapped. If we want 10000 good ones, then we need to have:

$$X - .07X = 10000$$

$$\text{or } (1 - .07)\,X = 10000$$

$$\text{or } \quad .93X = 10000$$

$$\text{and } \quad X = 10000/.93 = 10752.7$$

Thus we need to start 10753 scoops to get 10000 good ones.

As evaluation, we could compare this with what happened before. When we started 10700, we got only 9951 good ones, or the 49 short we would expect. However, starting 11000 (adding 10%) as was done previously, results in more than enough. Thus, it appears that our new method will solve the problem.

You should also think about how this would be implemented. You could computerize it, but an easier way might be to just post a sheet showing how many to start to get different numbers of good scoops.

Conclusion

This has shown you the steps you will be following on all projects. You should go back and refresh your memory on what they were. Also notice how each step was performed. The next project will count toward your course grade.

APPENDIX B

Peer Evaluation Forms

ADSC 352

Project Group Evaluation Form

Project Number____________ Group Name____________

The ratings you provide on this form will be used to determine individual grades for your fellow group members. Thus, if you feel that someone has contributed less than their fair share or has done an outstanding job you can reflect those feelings on this evaluation form. Remember, if you let your fellow group members know that they are doing a poor job through these evaluations then it is likely that they will contribute more in the future. Likewise, rewarding those who have worked hard will probably mean they will continue that behavior.

As you consider the extent of each group member's contribution, you should think about the following criteria.

1. Frequency of attendance at group meetings.
2. Efforts in terms of defining/clarifying the group task.
3. Helping to ensure that the final product is done **well.**
4. Contributed his/her fair share of calculations.
5. Drafted his/her fair share of the final report.
6. Contributed time.
7. Contributed ideas.
8. Contributed leadership.

Rate each group member, **excluding yourself,** in terms of the above criteria. List the names of the group members, **but not yourself,** in the space below. Then assign a number of points to each person to reflect his/her rating. These ratings **must total 100.** Thus, someone who contributed more will receive a higher number of points. Someone who contributed less will receive fewer points. Remember, the points **must total 100.**

Group member names	**Points assigned**
1. ____________________	____________
2. ____________________	____________
3. ____________________	____________
4. ____________________	____________
Total:	100

Your Name:____________________

Group Evaluation Form

Date: ____________ Project: ____________________

Your Name: ____

The ratings you will provide on this form will be used to assist in assigning points to your fellow group members, and therefore, will be used in making final grade assignments in the course. With respect to case presentations and the term project, the instructor will make the initial evaluation and then use the peer evaluations to assign the same or lower number of points to each student. Thus, if you feel that a particular person has not fully contributed, done so in a careless manner, or even prevented the group from making meaningful progress toward the final project, you now have the opportunity to express your feelings and thereby, help insure that this student does not fully benefit from the efforts of those who have worked hard and well on the project. Likewise, students who have worked hard on the project should be rewarded for their efforts.

As you consider the extent of contribution of each group member, consider the following:

1. Frequency of attendance at group meetings.
2. Efforts in terms of defining/clarifying the group task.
3. Helping to insure that the final product is done **well** (held/enforced high standards).
4. Drafted his/her fair share of the final report.
5. Typed his/her fair share of the final report.
6. Proofread final report and attended to details.
7. Contributed ideas.
8. Contributed time.
9. Contributed leadership.
10. Contributed effort.

Group Member Names:	Points Assigned: Up to 100 pts/person

ADSC 485

Peer Evaluation For The Simulation Questionnaire

ASSIGNMENT

Your Name: ____________________ Group #: __________

Instructions:

Rate each of your group members including yourself on each of the items listed below, as objectively as possible. List the names in the blocks below according to the alphabetical order of the last names of the group members. Then, for each question write the number that is most applicable as per the scale below.

1	2	3	4	5
Very Little				Very Much

GROUP MEMBERS' NAMES

	1	2	3	4
Items:				
1. Attended meetings.	____	____	____	____
2. Planned activities.	____	____	____	____
3. Assumed leadership role.	____	____	____	____
4. Participated in discussions.	____	____	____	____
5. Contributed in evolving a logical set of variables.	____	____	____	____

GROUP MEMBERS' NAMES

	1	2	3	4
6. Identified the correct questions to be asked for each variable.	___	___	___	___
7. Offered help in developing the scales for the items, and in general, improving the questionnaire.	___	___	___	___
8. Contributed substantially to critiquing the questionnaire.	___	___	___	___
9. Evolved strategies and identified the steps for Survey Feedback.	___	___	___	___
10. All in all, a valuable member of the group.	___	___	___	___
Total (Make sure you add up)	___	___	___	___

If you had to allocate among your group members a TOTAL of 100 points, how much would each person get. ___ + ___ + ___ + ___ = 100

Any additional comments you may wish to make relating to members' contributions to the group. Use the back of this sheet also.

Must be handed over to the instructor
in class in the attached envelope.

485/Q

ADSC 341

Project Group Evaluation Form

Your Name:____

Group Project Title:____________________________________

The ratings you will provide on this form will be used to assist in assigning course points to your fellow group members, and therefore, will be used in making final grade assignments in this course. Each project will receive a project grade (maximum project points = 50). Each group member will receive a number of points for the group project based on the particular grade that is assigned and the **individual contributions** made toward that final group effort. The instructor will evaluate the overall finished project. Group members will provide information on the relative contributions made by all members of the project group. Thus, if you feel that one particular person has not fully contributed, done so in a careless manner, or even prevented the group from making meaningful progress toward the final product, you now have the opportunity to express your feelings, and help insure that this student does not fully benefit from the efforts of those who worked hard and well on this project. Likewise, students who contributed fully to this project and whose efforts helped to make it a good one should be rewarded for their efforts. In effect, you can help to insure that students who contributed more receive more points than students who contributed less.

As you consider the extent of contribution of each group member, consider the following:

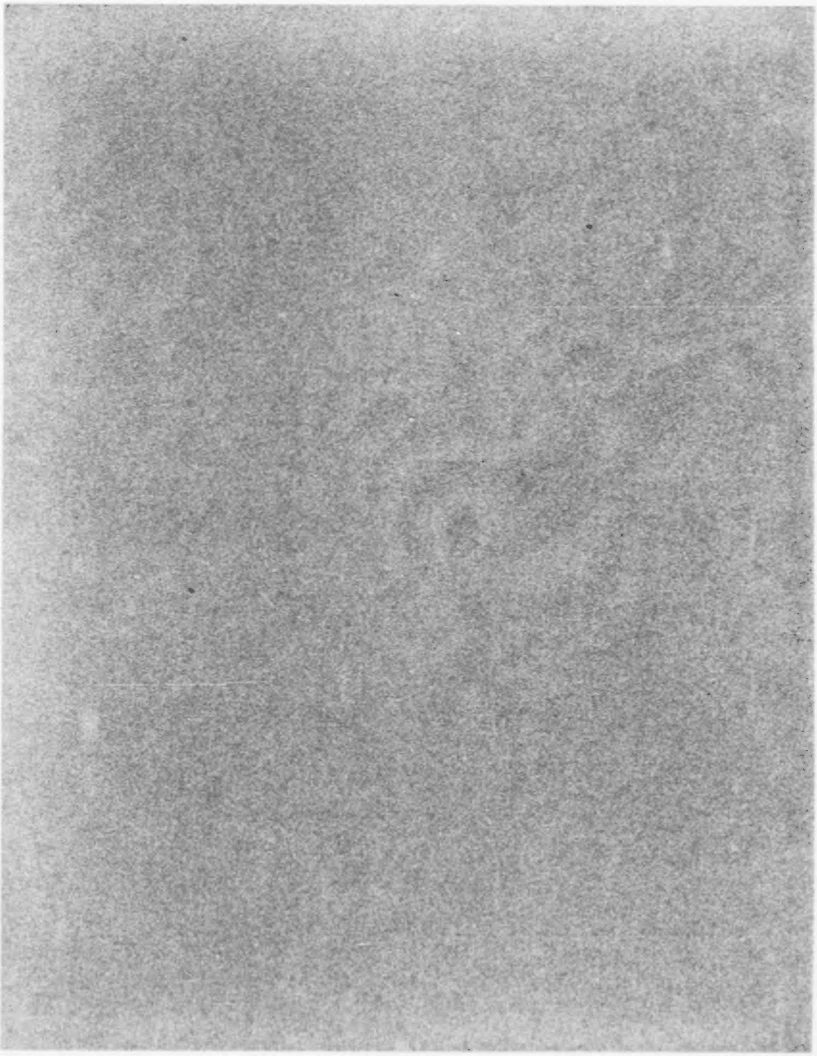
1. Frequency of attendance at group meetings
2. Efforts in terms of defining/clarifying the group task
3. Helping to insure that the final product is done **well** (held/enforced high standards)
4. Drafted his/her fair share of the final report
5. Typed his/her fair share of the final report
6. Proofread final report and attended to details
7. Contributed ideas
8. Contributed time
9. Contributed leadership
10. Contributed effort

Instructions: Rate each group member, **excluding yourself,** in terms of the contributions made toward the overall group project. Write the NAMES (neatly) of all group members in the space provided. Then, allocate **100 points** among your group leaders in such a fashion as to express your beliefs about person's contributions to the overall group project. That is, assign each person a number of points such that (1) a higher number of points express your belief of greater contributions and (2) the sum of all points assigned **cannot exceed 100.**

Group Member Names	Points Assigned
1. ____________________	____________
2. ____________________	____________
3. ____________________	____________
4. ____________________	____________
5. ____________________	____________
6. ____________________	____________
____________________	____________
	100 points total

APPENDIX C

FORTRAN Program For Class Record Keeping



```
                         GRADE REPORTING PROGRAM
C
C
C     DATA CARDS ARE AS FOLLOW:
C
C     1 -- COURSE NUMBER, SECTION NUMBER, MONTH, DAY, YEAR,
C      NUMBER OF ASSIGNMENTS COMPLETED, TOTAL POINTS COMPLETED
C      IE 48101010980020200  FORMAT(I3,5I2,F4.0)
C      (SET TOTAL POINTS COMPLETED = 0000 TO PRINT A BLANK GRADE
C       SHEET.)
C
C     2 -- ID NUMBER, NAME, GROUP NUMBER, GRADES, FINAL
C      IE 999226666 BILL SMITH     12345   85  75  80  89  90  85
C      89 100  90  95  86  76  87.2  FORMAT(I9,1X,5A3,I6,12I4,F5.1)
C
      DIMENSION LX(12)
C     ARRAY LX WILL CONTAIN THE GRADES.  IT IS SET UP NOW TO
C      HANDLE 12 GRADES.  THIS NUMBER MAY BE CHANGED.
C
      DIMENSION W(13)
C     ARRAY W CONTAINS THE WEIGHTS FOR EACH GRADE.  W(13) IS THE
C      WEIGHT FOR A FINAL.  INDIVIDUAL VALUES OF THE WEIGHTS ARE
C      ENTERED BELOW.  THERE MAY BE LESS THAN 13.
      W(1)=0.0
      W(2)=.05
      W(3)=.45
      W(4)=.5
      W(5)=.1
      W(6)=.9
      W(7)=1.0
      W(8)=.1
      W(9)=.9
      W(10) = 1.0
      W(11) = .1
      W(12) = .9
      W(13) = 1.0
C
C     THE FOLLOWING FORMAT PRINTS A PAGE HEADING OF COURSE NUMBER
C      AND SECTION.  THIS MAY BE CHANGED.
C
1     FORMAT('1'/,40X,'ADMINISTRATIVE SCIENCE ',I3,' SECTION ',I2)
2     FORMAT(//,45X,I2,' - ',I2,' - ',' 19',I2)
C
C     THE FOLLOWING IS USED TO PRINT COLUMN HEADINGS.  THESE MAY
C      BE ALTERED, BUT EACH MUST BE FIVE CHARACTERS (INCLUDING
C      BLANKS).
3     FORMAT(///,15X,'TOTAL GROUP QUIZ1 PROJ1 TEST1 QUIZ2 PROJ2
     -TEST2 QUIZ3 PROJ3 TEST3 QUIZ4 PROJ4 FINAL')
C
4     FORMAT(/,120('*'),//)
6     FORMAT(I3,5I2,F4.0)
7     FORMAT(//)
15    FORMAT(I9,1X,5A3,I6,11I4,F5.1)
12    READ(5,6)ICLASS,SEC,MO,IDAY,IYR,NASN,VAL
5     J1=0
      WRITE(6,1)ICLASS,SEC
      WRITE(6,2)MO,IDAY,IYR
      WRITE(6,3)
      WRITE(6,4)
17    READ(5,15,END=16)ID,$N1,$N2,$N3,$N4,$N5,
     1(LX(I),I=1,12),FIN
      AV=0.0
      DO 51 J=2,12
51    AV=AV+(LX(J)*W(J))
      AV = AV + FIN*W(13)
      WRITE(6,81) ID,AV,(LX(I),I=1,12),FIN,$N1,$N2,$N3,$N4,$N5
81    FORMAT(/' ',I9,4X,F6.2,12I6,F6.1,5X,6A3)
82    J1=J1+1
      IF(J1.GE.25) GO TO 10
11    GO TO 17
10    J1=0
      WRITE(6,4)
      WRITE(6,1)ICLASS,SEC
      WRITE(6,2)MO,IDAY,IYR
      WRITE(6,3)
      WRITE(6,4)
      GO TO 11
16    WRITE(6,7)
13    STOP
      END
```

APPENDIX D

Sample Guidelines for Project Grading

ADSC 318

Project Reports

At the conclusion of each project in this course your group will be expected to submit a written report describing the solution you have developed. You should consider yourselves as company employees who have been given this problem to solve. Your report should describe the problem background, present your solution, and provide relevant backup material, such as calculations, to support your work.

Report Format

The format of your report is up to you. However, it should follow a logical sequence and present your solution in a concise manner. A recommended format is:

1. Background of the problem
2. Statement of objective
3. Explanation of assumptions
4. Development of the final solution
5. Suggestions for implementation
6. Appendices containing supporting data and detailed calculations.

Try to avoid including too much mathematical detail in the **body** of your report. Present mostly results. However, these results should be supported by detailed calculations in the appendices.

The work of each person should be clearly indicated in the report. In general, the leader will be responsible for the body of the report. The work of the planners and researcher will show up in the appendices. Be sure to mark clearly who did each part so that each person can be graded accordingly.

Do's and Don'ts

It is expected that these reports will be written clearly. Be especially careful of poor sentence structure and incorrect spelling. Some words to watch are: analyze, develop, morale, environment. Also be sure to use the correct one in each of the following cases:

there vs. their
your vs. you're

All reports **must** have the body typed. Mathematical calculations, tables, and graphs need not be typed if they are written **neatly** in **ink.**

You should be sure to note that each report **must** include some outside research or use of the computer.

Grading

Your reports will be graded on clarity of presentation. Points will be taken off for poor sentence structure, incorrect spelling, and math errors. However, the general **range** of your report's grade will be determined by the following scale based on your effort.

Maximum grade	**Requirements**
70%	Use one of the techniques presented in the self-instruction and briefly describe another from outside resources.
80%	Use at least two different techniques from the self-instruction and either briefly describe another from outside resources or use a simple computer program.
90%	Apply some technique, not discussed in the self-instruction, to your problem solution or use a complex program to do calculations.
100%	Apply a complicated technique not discussed in the self-instruction to your problem solution.

Project I - Forecasting

This project requires that you develop both a short range and a long range forecast. Depending on how well you do this and whether you put any extra effort into the project, your group's report grade may vary from 70% to 95% (there will be no perfect grades) for a completed report turned in on time. The following will give you an idea of what you must do to achieve a given grade. For **all** of these you must provide short and long range forecasts.

Maximum grade	**Suggested Requirements**
75%	**Correctly** calculate both the short range and long range forecasts using appropriate forecasting methods as presented in the self-instruction materials.
80%	**Correctly** calculate short range and long range forecasts and evaluate the different results produced by various smoothing constants for exponential smoothing, compare the results obtained with different independent variables for regression, or try using various numbers of years of historical data and compare the results.
85%	Write and use a computer program to perform your exponential smoothing calculations **or** correctly use **multiple** regression for the long range forecast **or** survey current forecasting literature and indicate how it may be applied to the current problems.
90%	Use **adaptive** exponential smoothing, double or triple smoothing or some other advanced method.
95%	Do something beyond what is listed above.

References

The references listed below are available in the Self-Instruction Center of the library.

R. Peterson and E. Silver, *Decision Systems for Inventory Management and Production Planning*, pp. 102-144.
A good basic overview of double, triple, and adaptive exponential smoothing as well as Winters' model and Box-Jenkins.

O. Anderson, *Time Series Analysis and Forecasting: The Box-Jenkins Approach*
A rather difficult book concerned entirely with the Box-Jenkins method of forecasting.

B. Bowerman and R. O'Connell, *Forecasting and Time Series.*
A good text covering forecasting in general, exponential smoothing (including double and triple) and Box-Jenkins.

O. Wight, *Production and Inventory Management in the Computer Age*, pp. 147-167.
Basic discussion of the concept of forecasting and the use of forecasts.

R. Brown, *Materials Management Systems: A Modular Library*, pp. 73-122.
A good overview of forecasting by a pioneer in the field. Discusses smoothing constants.

R. Brown, *Smoothing, Forecasting, and Prediction of Discrete Time Series.*
Brown's original work on exponential smoothing. Quite mathematical, but it discusses **everything** including derivations and proofs of the formulas.

C. Chambers, S. Mullick, and D. Smith, "How To Choose the Right Forecasting Technique"
Compares alternative forecasting methods, discussing pros and cons of each.

ADSC 318

Project II

The following is a set of guidelines which you can use to determine what level of work will achieve a given grade. Remember that **supporting data, explanations** and **correct and detailed calculations** are very important.

Maximum grade	**Suggested Activities**
75%	Develop aggregate plans using each of the three pure strategies and compare their costs. Use the pure strategy which you think is best to develop an ordering schedule.
80%	Develop aggregate plans using each of the three pure strategies. Combine them into a 'mixed strategy.' You **must** justify your mixed strategy. Develop an ordering schedule based on the mixed strategy.
85%	Do the work for an 80, incorporating safety stocks in your strategy OR Do the work for an 80 and conduct a survey of current literature on planning.
90%	Do the work for an 80 and write and run a computer program to perform your MRP calculations OR Do the work for the research option for an 85 and apply any one method or model that you have researched to the project.
95%	Do the work for an 80 and formulate the aggregate schedule as an LP problem OR Do something equivalent.

REFERENCES

P. Rhodes, "A Paint Industry Production Planning and Smoothing System," a good example of how forecasting, aggregate planning, and MRP tie together.

D. Anderson, D. Sweeney, and T. Williams, *An Introduction to Management Science,* pp. 204-216. An example of how LP can be applied to aggregate planning.

J. Orlicky, *Material Requirements Planning.* Absolutely the major work on MRP by its founding father.

T. Vollmann, "Production Planning and Inventory Control Systems." A good overview of MRP and master scheduling, with lots of examples.

R. Hall and T. Vollmann, "Planning Your Material Requirements." An excellent example of how MRP should be implemented.

J. Miller and L. Sprague, "Behind the Growth in Material Requirements Planning." A simple overview of what MRP is and how it works.

R. Everdell, "Master Production Scheduling." An overview of master scheduling and how it relates to capacity.

R. Peterson, and E. Silver, *Decision Systems for Inventory Management and Production Planning.* pp. 598-662. Gives details of aggregate planning, including mathematical models.

O. Wight, *Production and Inventory Management in the Computer Age,* pp. 23-47, 59-77. An overview of MRP and master scheduling.

R. Brown, *Materials Management Systems: A Modular Library,* pp. 265-315. A detailed explanation of master scheduling and MRP.